Alaska Outer Continental Shelf

OCS EIS/EA
BOEMRE 2011-041

Chukchi Sea Planning Area

Oil and Gas Lease Sale 193
In the Chukchi Sea, Alaska

Final Supplemental Environmental Impact Statement

Volume I. Chapters I – VI and Appendices A, B, C, D

U.S. Department of the Interior
Bureau of Ocean Energy Management,
Regulation and Enforcement
Alaska OCS Region

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Bureau of Ocean Energy Management, Regulation and Enforcement
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Regulation, and Enforcement
Alaska OCS Region

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COVER SHEET

Chukchi Sea
Lease Sale 193
Supplemental Environmental Impact Statement

Draft ( ) **Final (X)**

Type of Action: Administrative (X) Legislative ( )

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

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Abstract

This Supplemental Environmental Impact Statement (EIS) addresses Outer Continental Shelf (OCS) Oil and Gas Lease Sale 193, Chukchi Sea, Alaska.

Secretarial Order No. 3302 dated June 18, 2010, renamed the Minerals Management Service (MMS) as the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE).

The Outer Continental Shelf Lands Act of 1953 (OCSLA), as amended (43 U.S.C. 1331 et seq. [2008]), established Federal jurisdiction over submerged lands seaward of State boundaries. Under the OCSLA, the Department of the Interior (DOI) is required to manage the leasing, exploration, development, and production of oil and gas resources on the Federal OCS. The Secretary develops the five-year OCS oil and gas program to balance orderly resource development with protection of the human, marine, and coastal environments while simultaneously ensuring that the public receives an equitable return for these resources and that free-market competition is maintained. The OCSLA empowers the Secretary to grant leases to the highest qualified responsible bidder(s) on the basis of sealed competitive bids and to formulate such regulations as necessary to carry out the provisions of the Act. The Secretary has designated BOEMRE as the agency responsible for the mineral leasing of submerged OCS lands and for the supervision of offshore operations after lease issuance, in accordance with the provisions of the OCSLA.

The OCSLA prescribes a four-stage process for oil and gas development. This four-level review process gives the Secretary a "continuing opportunity for making informed adjustments" (*Sierra Club v. Morton*, 510 F.2d 813, 828 [5th Cir. 1975]) to ensure that all OCS oil and gas activities are conducted in an environmentally sound manner. In the first stage, the Secretary (through BOEMRE) prepares a 5-year leasing program to identify the size, timing, and location of proposed lease sales and an environmental document under NEPA. In the second stage, BOEMRE conducts the prelease process for sale-specific NEPA reviews. If BOEMRE proceeds with a sale, BOEMRE conducts a sealed-bid auction, opens the bids it receives, evaluates the bids for fair market value, and issues the leases. The third stage involves exploration of the leased tracts. Prior to any exploratory drilling, a lessee must submit an exploration plan (EP) to BOEMRE for review and approval. The EP must comply with the OCSLA, implementing regulations, lease provisions, and other Federal laws, and is subject to environmental review under NEPA. The BOEMRE must disapprove an EP if the proposed activities would cause "serious harm or damage" to the marine, coastal, or human environment. If the EP is approved, the lessee

must also apply for specific permits needed to conduct the activities as described in the EP. The fourth stage, development, is reached only if a lessee finds a commercially viable oil and/or gas discovery. A lessee must submit a detailed development and production plan (DPP) that BOEMRE must review under NEPA. If the DPP is approved, the lessee must also apply for specific pipeline, platform, and other permits for approval.

In January 2008, the MMS issued a Final Notice of Sale for Chukchi Sea OCS Oil and Gas Lease Sale 193 to be conducted in February 2008. On January 31, 2008, a lawsuit was filed alleging violations pursuant to NEPA and the Endangered Species Act [*Native Village of Point Hope v. Salazar*, No. 1:08-cv-00004-RRB (D. Alaska)]. Sale 193 was held in February 2008. Although the lease-sale decision was challenged in the U.S. District Court for the District of Alaska (District Court), the plaintiffs did not request a preliminary injunction to stop the sale. On July 21, 2010, the District Court issued an Order remanding Sale 193 to BOEMRE to satisfy its obligations under NEPA in accordance with the Court's opinion. This District Court's Order was amended on August 5, 2010, and guidelines for compliance with the Order were established by the Court on September 2, 2010.

Pursuant to the amended Order, BOEMRE was instructed to address three concerns, as follows:

- Analyze the environmental impact of natural gas development.
- Determine whether missing information identified by BOEMRE in the 193 Final EIS was essential or relevant under 40 CFR 1502.22.
- Determine whether the cost of obtaining the missing information was exorbitant, or the means of doing so unknown.

On October 5, 2010, BOEMRE issued a Notice of Intent to Prepare a Supplemental Environmental Impact Statement: Outer Continental Shelf, Alaska OCS Region, Chukchi Sea Planning Area, Oil and Gas Lease 193.

The Draft SEIS augmented the analysis in the Sale 193 Final EIS by analyzing the environmental impact of natural gas development and evaluating incomplete, missing, or unavailable information pursuant to 40 CFR 1502.22 (Appendix A) to respond to the Court's remand. A Draft SEIS was made available to the public on October 15, 2010, and a 45-day public review and comment period commenced. Over 150,000 comments were submitted. Many commenters requested that BOEMRE perform an analysis that takes into account the possibility of a blowout during exploration activities, in view of the *Deepwater Horizon* event.

In March 2011, BOEMRE announced a Very Large Oil Spill (VLOS) analysis would be included in the SEIS. The analysis was completed and integrated within the Revised Draft SEIS.

The Revised Draft SEIS relied on the existing analysis provided by the Sale 193 FEIS where appropriate, and adds (1) new analysis on the environmental impact of natural gas development, (2) an evaluation of incomplete, missing, or unavailable information pursuant to 40 CFR 1502.22 (Appendix A), and (3) new analysis of a hypothetical VLOS scenario. The Revised Draft SEIS also included revisions in light of comments received on the Draft SEIS and analyzed additional information which had become available since the publication of the Sale 193 Final EIS. On May 27, 2011, the Revised Draft SEIS was released to the public with a 45 day public comment period ending July 11, 2011. In June 2011, the BOEMRE held public hearings in Alaska communities and government-to-government consultations with affected tribes. Approximately 360,000 comment letters or cards were received from various entities.

In preparing the Sale 193 Final SEIS, BOEMRE has responded to the public comments and considered information from the USGS report "An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas, Alaska" (released June 23, 2011). The Final SEIS satisfies the concerns addressed by the District Court in its remand order, provides a comprehensive VLOS analysis, and together with the Sale 193 FEIS provides the Secretary with sufficient information to affirm, modify, or cancel the Department's previous decision on Sale 193.

Acronyms and Abbreviations

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AAC ....Alaska Administrative Code
ACIA ....Arctic Climate Impact Assessment
ACP ....Arctic Coastal Plain
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
AFMP ....Arctic Fishery Management Plan
AI/AN............................American Indian and Alaskan Native populations
ANC ....Alaska Nanuuq Commission
ANCSA ....Alaska Native Claims Settlement Act
ANILCA........................Alaska National Interest Land Conservation Act
ANS...............................aquatic nuisance species
ANWR...........................Arctic National Wildlife Refuge
API ....American Petroleum Institute
APD...............................Application for Permit to Drill
ARBO............................Arctic Region Biological Opinion
ASRC ....Arctic Slope Regional Corporation
ASWG ....Alaska Shorebird Working Group
atm.................................atmosphere (of pressure)
bbls ....barrels
bbls/d ....barrels per day
Bcf ....billion cubic feet
Bcfg ....billion cubic feet of gas
BCB...............................Bering-Chukchi-Beaufort Seas stock of bowhead whales
BE..................................Biological Evaluation
BLM ....Bureau of Land Management
BO ....Biological Opinion
BOEM ....Bureau of Ocean Energy Management, Regulation, and Enforcement
BOP ....blowout preventer (system)
B.P. ....Before Present
BP ....British Petroleum
BPXA ....British Petroleum Exploration (Alaska)
CAA ....Clean Air Act or Conflict Avoidance Agreement
CAH ....Central Arctic (caribou) Herd
CBD...............................Center for Biological Diversity
CBS ....Chukchi/Bering Seas stock of polar bears
CEQ...............................Council on Environmental Quality
CER ....Categorical Exclusion Review
CFCs..............................chlorofluorocarbons
CFR ....Code of Federal Regulations
CI...................................confidence interval
CIAP..............................Coastal Impact Assistance Program
CIP.................................Capital Improvement Program
CO ....carbon monoxide
cp ....centipoise (measure of viscosity)
CPAI..............................Conoco Phillips Alaska Incorporated
CWA..............................Clean Water Act
CZARA ....Coastal Zone Act Reauthorization Amendments of 1990
CZMA ....Coastal Zone Management Act
CZMP ....Coastal Zone Management Program (or Plan)
DEW..............................Distant Early Warning (system)
DO ....dissolved oxygen

DPP............................... Development and Production Plan
Draft EIS....................... Draft Environmental Impact Statement
Draft SEIS .... Draft Supplemental Environmental Impact Statement
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
EWC .... Eskimo Walrus Commission
FEIS............................. Final Environmental Impact Statement
Final SEIS..................... Final Supplemental Environmental Impact Statement
FMP .... Fishery Management Plan
FONSI .... Finding of No Significant Impact
FOSC .... Federal On-Scene Coordinator
FR .... Federal Register
FSB.............................. Federal Subsistence Board
FWPCA .... Federal Water Pollution Control Act
FWS............................. Fish and Wildlife Service
G&G .... geological and geophysical
Hz .... Hertz
IAP............................... Integrated Activity Plan
ICAS .... Inupiat Community of the Arctic Slope
IHA .... Incidental Harassment Authorization
IMO .... International Maritime Organization
IPCC .... Intergovernmental Panel on Climate Change
ISB............................... in-situ burn
ISC............................... Ice Seal Committee
ISER .... Institute for Social and Economic Research
IWC .... International Whaling Commission
ITA .... Incidental Take Authorization
ITL............................... Information to Lessees (Clauses)
IUCN .... International Union for Conservation of Nature
LA................................ Launch Area
LNG............................. liquefied natural gas
LOA............................. Letter of Authorization
LS .... Land Segment
Mbbls........................... thousand barrels
MBTA .... Migratory Bird Treaty Act
Mcf .... thousand cubic feet
Mcf/d .... thousand cubic feet per day
Mcfg .... thousand cubic feet of gas
md................................ millidarcy (measure of permeability)
MMbbls .... million barrels
MMC .... Marine Mammal Commission
MMcf........................... million cubic feet
MMcfg......................... million cubic feet of gas
MMPA......................... Marine Mammal Protection Act
MMS............................ Minerals Management Service
MOU............................ Memorandum of Understanding
NAAQS .... National Ambient Air Quality Standards
NEPA........................... National Environmental Policy Act
NPFMC .... North Pacific Fisheries Management Council

NHPA............................National Historic Preservation Act
NISA..............................National Invasive Species Act of 1996
NMFS............................National Marine Fisheries Service
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
NSB...............................North Slope Borough
NSBMC.........................North Slope Borough Municipal Code
NSBSAC.......................North Slope Borough Science Advisory Committee
NSIDC...........................National Snow and Ice Data Center
NTAC's.........................Nondiscretionary Terms and Conditions
NTL...............................Notice to Lessees
O_3..................................ozone
OCRM...........................Ocean and Coastal Resource Management
OCS...............................Outer Continental Shelf
OCS Lands Act..............Outer Continental Shelf Lands Act
OPA/OPA-90.................Oil Pollution Act of 1990
OSFR.............................Oil Spill Financial Responsibility
OSRA............................Oil Spill Risk Analysis
OSRP.............................Oil Spill Response Plan
PAC's............................polyaromatic compounds
PAH's............................polycyclic aromatic hydrocarbons
PEA...............................Programmatic Environmental Assessment
PM.................................particulate matter
PM_{10}..............................particulate matter less than 10 microns in diameter
PSD................................Prevention of Significant Deterioration
RCRA............................Resource Conservation and Recovery Act
RD.................................Regional Director
ROD..............................Record of Decision
ROI................................record of increase
ROW.............................right-of-way
RP..................................Responsible Party or Recommended Practice
RPM's............................Reasonably Prudent Measures
RS/FO............................Regional Supervisor/Field Operations
RSV...............................Royalty Suspension Volume
Sale 193.........................Chukchi Sea OCS Lease Sale 193
SBS................................southern Beaufort Sea stock of polar bears
scf..................................standard cubic foot
SDH...............................social determinants of health
Secretary........................Secretary of the Interior
SEIS...............................Supplemental Environmental Impact Statement
SIP.................................State Implementation Plan
SLA...............................Submerged Lands Act
SLS................................Spring Lead System
SO_2................................sulfur dioxide
SO_4................................sulfate
stb..................................stock-tank or standard barrel
TAPS.............................Trans-Alaska Pipeline System
Tcf.................................trillion cubic feet
Tcfg...............................trillion cubic feet of gas
TEK...............................traditional environmental knowledge
TLH...............................Teshekpuk Lake (caribou) Herd

UAF .... University of Alaska, Fairbanks
U.S.C. .... United States Code
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
VLOS .... very large oil spill
VOC .... volatile organic compounds
WAH .... Western Arctic (caribou) Herd
WCD .... Worst Case Discharge

Executive Summary

Executive Summary

1. The Proposed Action

In June 2007, the U.S. Department of the Interior (USDOI) Minerals Management Service released a "Final Environmental Impact Statement for Oil and Gas Lease Sale 193 and Seismic-Surveying Activities in the Chukchi Sea" (USDOI, MMS, 2007a), hereafter Sale 193 FEIS. The purpose of the proposed action addressed in the Sale 193 FEIS is (1) to offer for lease areas in the Chukchi Sea Planning Area of the Alaska Outer Continental Shelf (OCS) that might contain economically recoverable oil and gas resources and (2) to provide analyses for exploration seismic-survey activities.

After the Secretary of the Interior selected Alternative IV of the FEIS, Sale 193 was held in February 2008. However, the decision to hold the sale was the subject of litigation. By Secretarial order dated June 18, 2010, the Minerals Management Service was renamed Bureau of Ocean Energy Management, Regulation and Enforcement. On July 21, 2010, the United States District Court for the District of Alaska issued an Order remanding the Sale 193 matter to BOEMRE to satisfy its obligations under the National Environmental Policy Act (NEPA), in accordance with the Court's opinion. Pursuant to the amended Order, BOEMRE was instructed to address three concerns, as follows:

- Analyze the environmental impact of natural gas development.
- Determine whether missing information identified by BOEMRE in the 193 FEIS was essential or relevant under 40 CFR 1502.22.
- Determine whether the cost of obtaining the missing information was exorbitant, or the means of doing so unknown.

BOEMRE produced a Draft Supplemental EIS (SEIS) to address these concerns and made this document available to the public for a 45-day period (October 15–November 30, 2010); as a result, over 150,000 public comments were received. Many of these comments requested that BOEMRE perform an analysis that takes into account the possibility of a blowout during exploration activities, in view of the *Deepwater Horizon* event. In March 2011, BOEMRE announced that it would incorporate a VLOS (Very Large Oil Spill) analysis into its ongoing SEIS process. In May 2011, BOEMRE issued a Revised Draft SEIS that included an environmental effects analysis of a VLOS scenario. An additional 45-day public comment period (May 27–July 11, 2011) was held and over 360,000 public comments were received.

This Final SEIS specifically addresses the three concerns of the Court and provides comprehensive analysis of a hypothetical VLOS scenario. This Final SEIS also summarizes and responds to comments received on both the Draft SEIS and the Revised Draft SEIS. Overall, this Final SEIS process, together with the Sale 193 FEIS, will provide the Secretary of the Interior (Secretary) with sufficient information and analysis to choose between lease sale alternatives and either affirm, modify, or cancel Lease Sale 193.

Regulatory Framework

The OCS leasing process is driven by the OCS Lands Act. The OCS Lands Act requires the USDOI to manage the orderly leasing, exploration, development, and production of oil and gas resources on the Federal OCS, while simultaneously ensuring the following: 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 USDOI must also comply with the National Environmental Policy Act (NEPA). NEPA requires the integrated use of natural and social sciences in any Federal agency planning and decision-making that may have an impact on the environment. To further this goal, NEPA requires Federal agencies to prepare a detailed EIS on major Federal actions significantly affecting the quality of the human environment. Other laws, regulations, and Executive Orders are also applicable to OCS activities.

BOEMRE Responsibility

Within the USDOI, BOEMRE is responsible for managing, regulating, and monitoring the oil and gas operations in the Federal OCS. BOEMRE's authority extends over all operations conducted under the lease, right of use and easement, or USDOI pipeline right-of-way. It carefully reviews and regulates all ancillary activities, geological and geophysical activities, exploration plans, development and production plans, and decommissioning. BOEMRE maintains and enforces regulations governing pipeline construction and maintenance, use of Best Available and Safest Technology, and Pollution Prevention and Oil-Spill-Response plans. At the heart of BOEMRE's enforcement is a robust inspection program. Consistent with NEPA, BOEMRE analyzes the potential environmental effects of its proposed actions affecting the Federal OCS.

2. Alternatives

The SEIS retains the alternatives analyzed in the Sale 193 FEIS (see Figure 1). These alternatives are as follows:

- Alternative I (Proposed Action): The Proposed Action offered for lease 6,156 whole or partial blocks within in the Chukchi Sea. This area covers approximately 34 million acres (13.8 million hectares). Specifically excluded from the Proposed Action was the 25 Statute Mile Buffer implemented by the Secretary in the Final OCS Leasing Program for 2007–2012, which extends from the Alaska coast.
- Alternative II (No Lease Sale): This is the no action alternative, which in this case is equivalent to not affirming Sale 193.
- Alternative III: This alternative is the Proposed Action minus a corridor encompassing the proposed sale blocks within approximately 60 miles of the Alaska coast. This "Corridor I" deferral area would protect important bowhead whale habitat used for migration, feeding, nursing calves, and breeding while reducing potential for future commercial oil and gas production by 36% compared to the Proposed Action. In total, Alternative III would offer approximately 1,765 whole or partial blocks comprising 9.1 million acres (3.7 million hectares). If the Secretary selects Alternative III, the majority of leases issued under Chukchi Sale 193 could be affirmed; however, twelve leases were issued on blocks within Corridor I (deferred under Alternative III).
- Alternative IV: This alternative is the Proposed Action minus approximately 795 whole or partial blocks along the coastward edge of the sale area. The "Corridor II" deferral area is a subset of the Corridor I deferral area analyzed under Alternative III. Alternative IV was identified as the Agency's Preferred Alternative in the 193 FEIS, and was offered for lease as Sale 193 (February 2008). Under this Alternative the potential for commercial oil and gas production was reduced by 15% compared to the Proposed Action. Selection of Alternative IV would be equivalent to affirming Sale 193 as held.

Preferred Alternative

BOEMRE's preferred alternative is Alternative IV. New information considered in the environmental analysis for this SEIS supports the agency's preference for Alternative IV. Further support is provided by the NMFS 2008 Biological Opinion, which concluded that oil and gas leasing and exploration in the Chukchi Sea is not likely to jeopardize the continued existence of the endangered fin, humpback, or bowhead whales.

3. Description of the Environment

The description of the physical, biological, and socioeconomic conditions within the action area is summarized. New information relevant to the analysis of natural gas development and production and/or a VLOS is also summarized.

Physical Environment

The Sale 193 area is located entirely within the U.S. Chukchi Sea, a part of the Arctic Ocean off the northwest coast of Alaska. Within this portion of the Chukchi Sea are three distinct currents: the Bering Shelf Current, the Anadyr Current, and the Alaska Coastal Current. Most (about 98%) of the Sale 193 area covers the relatively shallow continental shelf adjacent to the Arctic Ocean. Onshore, the Arctic Coastal Plain is a flat region that gradually increases in relief to the south towards the foothills of the Brooks Range. Climate in the action area is polar tundra and characterized by moderate winds, cold temperatures in the winter, cool temperatures in the summer, and little annual precipitation. At present, the Chukchi Sea is almost totally ice-covered from early December to mid-May. However, satellite and ice buoy data have shown that Arctic sea ice extent has decreased. There are three general forms of sea ice in the Sale 193 area: landfast ice, stamukhi ice, and pack ice. Biologically important polynyas develop between the landfast zone and pack-ice zone, extending along much of Alaska's Chukchi coast in the winter and spring months. Water quality and air quality are relatively high in the proposed action area.

Biological Environment

Primary productivity (pelagic as well as benthic) in the Chukchi Sea shelf region is considered the highest of any shelf region in the world due to the influence of several ocean currents. The Chukchi Sea is relatively rich in benthic faunal resources as compared to other Arctic shelves. Many species of fish are also present here. Essential Fish Habitat (EFH) has been designated for all five species of Pacific salmon, and for Arctic cod, saffron cod, and opilio crab. There are an abundance of marine mammals that use the Chukchi Sea, most notably the bowhead and beluga whales, polar bears, Pacific walrus, and several species of seals. Several species are classified as endangered, threatened, or candidate species under the Endangered Species Act (ESA). The region is also important to a wide variety of marine and coastal birds, including several ESA-listed and candidate species. Onshore, caribou are considered by many to be the most important animal species inhabiting the predominately tundra and wetland environment.

Socioeconomic Environment

The coastline adjacent to the Sale 193 area is home to several small village communities inhabited largely by Iñupiat peoples. Communal subsistence harvest of marine and terrestrial resources is extremely important to the physical, social, and cultural health of these inhabitants. The tax base of the North Slope Borough, a major provider of employment and services in Chukchi coastal villages, consists mainly of high-value property owned or leased by the oil industry in the Prudhoe Bay area.

A largely undetermined amount of archaeological resources are also present in the proposed action area.

4. Environmental Consequences

Summaries of potential environmental consequences of the proposed action are presented for the natural gas scenario, and then for the VLOS scenario. Significance thresholds for several resources were revised and applied: Water Quality, Air Quality, Subsistence-Harvest Patterns, Sociocultural Systems, and Environmental Justice.

Natural Gas Scenario

The potential direct and indirect environmental impacts associated with natural gas development and production stemming from Sale 193 are analyzed. To facilitate an objective and well-informed analysis, BOEMRE developed a scenario outlining the specific components of natural gas development and production that could result from Sale 193. The scenario is based on the petroleum-resource potential of the Sale 193 area, the technology available to develop and produce oil and gas from the offshore area, and industry trends in northern Alaska.

It is anticipated that any natural gas development and production would be predicated on the discovery and production of commercially-viable oil deposits. This conclusion stems from several factors: the current and projected price of natural gas is not sufficient to independently justify the costs of full-scale exploration, development, and production in the Chukchi Sea (a frontier region); oil is comparatively more valuable; only a large deposit of oil would justify the requisite investment in infrastructure; and oil and gas typically occur together in the Chukchi Sea. Were a company to produce oil from a reservoir in the Chukchi Sea, it is likely that a large quantity of natural gas would remain available in the reservoir even as oil is being depleted. The cost of producing this natural gas (subsequent to the oil production) would be greatly reduced, given the fact that no additional exploration or drilling would be required, and that substantial infrastructure (i.e. offshore platform, wells, onshore facility, service roads, etc.) would already exist. Notable activities required to develop and produce this gas include:

- minor modifications to the existing platform and recompletion of existing wells
- construction of a new offshore pipeline (from platform to shoreline) within an existing submarine pipeline corridor
- expansion of an existing onshore production facility
- construction of an elevated onshore pipeline (from the production facility to the Trans-Alaska Pipeline System) within an existing pipeline corridor
- prolonged operation of the platform, onshore production facility, and other infrastructure

The scope of additional activities associated with natural gas development and production is expected to be limited; consequently, analysts found little potential for significant adverse effects. Although adverse effects are anticipated for several resource areas, these effects are predominately temporary and localized. Potential impacts for each resource area are summarized in Table ES-1 (below). Comparisons of the level of impacts associated with each alternative are compared to those described for the Proposed Action.

Table ES-1. New potential impacts as a result of the natural gas development and production scenario. For each resource area, types and levels of potential impacts are described for Alternative I-Proposed Action, then impacts for Alternatives III and IV are compared with Alternative I. Alternative II-No Action would have no additional impacts on any resource area.

Resource Area	Alt. I – Proposed Action (no deferral area)	Alt. III – Corridor I (largest deferral area)	Alt. IV – Corridor II (smaller deferral area)
Water Quality	Temporary and localized impacts from installing new gas pipelines and from small scale and infrequent deck drainage discharges. Very low impacts on regional water quality.	Larger deferral area increases minimum length of pipeline, which may increase impacts. Still very low, temporary, and localized impacts.	Smaller deferral area may increase potential for impacts relative to Alt I, but to lesser extent than Alt III. Impacts would remain temporary, localized and very low.

Resource Area	Alt. I – Proposed Action (no deferral area)	Alt. III – Corridor I (largest deferral area)	Alt. IV – Corridor II (smaller deferral area)
Air Quality	Minor impacts would occur from emissions of diesel marine engines and onboard generators. Small, local, and temporary impacts within compliance standards for Clean Air Act.	Larger deferral area could decrease impacts to communities from production platforms but also increase total emissions due to greater travel distances for marine vessels; potential impacts remain minor.	Smaller deferral area could also decrease effect of platform emissions to communities yet increase total emissions from vessels; potential impacts remain minor.
Lower Trophic Level Organisms	Adverse impacts would occur from installing an offshore pipeline and, to a lesser extent, from vessel anchoring. No significant impacts because recolonization is expected.	Highest potential for impacts due to longest minimum distance from platform to shore. Still no significant impacts.	More potential for impacts than Alt I due to longer minimum distance from platform to shore. Still no significant effects.
Fish	Direct adverse impacts would occur via disturbance by vessels and introduction of noise. Indirect adverse impacts could occur via changes to seafloor, riparian, or wetland habitat. Impacts would be localized, temporary, and minor.	Highest potential for impacts among action alternatives due to longest minimum distance from platform to shore. Impacts still localized, temporary, and minor.	More potential for impacts than Alt I due to longer minimum distance from platform to shore. Impacts still localized, temporary, and minor.
Essential Fish Habitat	Installing the offshore and onshore pipeline components could cause temporary and local impacts. Vessel noise could continue to cause temporary and minor impacts in production phase. No significant impacts expected.	Highest potential for impacts relative to Alt I due to longest minimum distance from platform to shore. No significant impacts expected.	More potential for impacts than Alt I due to longer minimum distance from platform to shore. No significant impacts expected.
Threatened & Endangered Marine Mammals	Noise associated with vessel traffic, aircraft traffic, and construction could have impacts. Section 7 consultation and compliance with MMPA take guidelines would help preclude level A or "harm" take or adverse effects to Critical Habitat. Impacts are expected to be minor.	Larger deferral area further protects polynyas and important near-shore areas from platform-related activities, but may also increase vessel and aircraft travel. May offer most protections overall.	Smaller deferral area designed in part to protect polynyas and important near-shore areas from platform-related activities. May also increase vessel and aircraft travel. Regulatory protections ensure impacts would remain minor.
Other Marine Mammals	Noise is the primary concern, but potential impacts would be reduced by compliance with MMPA. No significant effects or level A or "harm" take expected.	Largest deferral area excludes platform-related activities, but also means longest distances traveled by support vessels and aircraft. No significant effects or level A or "harm" take expected.	Smaller deferral area excludes platform-related activities, but also longer distances traveled by support vessels and aircraft. No significant effects or level A or "harm" take expected.
Threatened & Endangered Marine and Coastal Birds	Potential impacts could occur through habitat loss, disturbance, and displacement. Impacts would be minimized by section 7 consultation, and are not expected to reach significance.	Larger deferral area would move actions the farthest minimum distance from coastal areas occupied by birds, further reducing potential for impacts.	Smaller deferral area would move actions farther from shore than under Alt I, reducing potential for impacts.

Resource Area	Alt. I – Proposed Action (no deferral area)	Alt. III – Corridor I (largest deferral area)	Alt. IV – Corridor II (smaller deferral area)
Terrestrial Mammals	Proposed activities could disturb caribou, muskoxen, grizzly bears, and arctic foxes. Impacts temporary. Significant effects not expected.	Potential impacts the same as those for Alt I.	Potential impacts the same as those for Alt I.
Vegetation and Wetlands	While impacts from construction activities could cause long-lasting or even permanent effects, impacts would be highly localized and not significant on a regional scale.	Potential impacts the same as those for Alt I.	Potential impacts the same as those for Alt I.
Subsistence Harvest Patterns	No significant reductions to animal populations. However, proposed activities could disturb subsistence resources and alter their local availability to harvesters for a substantial portion of a subsistence season.	Deferral area would move actions the largest minimum distance from the coastline, further reducing potential to disturb subsistence resources or conflict with harvest.	Deferral area would move actions farther from the coastline than under Alt. 1, reducing the potential for disturbance to subsistence resources or conflict with harvest.
Sociocultural Systems	Some disruption to sociocultural systems could occur, especially if development occurs near a coastal community, where disruptions would have a tendency to displace existing social patterns.	Potential impacts the same as those for Alt I.	Potential impacts the same as those for Alt I.
Archaeological	Potential for construction activities to cause irreversible adverse impacts to currently unknown archaeological resources. Such effects could be significant. Standard protocols and mitigation measures would greatly reduce this potential.	Larger deferral area can increase potential for archaeological disturbance as a result of the need to construct a longer pipeline from the platform to the shore. Standard protocols and mitigation measures would reduce this potential.	Smaller deferral area; therefore, more potential for archaeological disturbance than Alt. 1, but less potential for archaeological disturbance than Alt. 3. Standard protocols and mitigation measures would reduce this potential.
Environmental Justice	Disproportionate, high adverse impacts to Alaska Inupiat Natives could occur through impacts to subsistence resources and sociocultural systems.	Potential impacts the same as those for Alt I.	Potential impacts the same as those for Alt I.
Economics	Gas development and production activities would generate economic activity. Increases in employment, personal income, and revenues to the government would occur in the NSB, the rest of AK, and the rest of the U.S.	Potential impacts the same as those for Alt I.	Potential impacts the same as those for Alt I.

VLOS Scenario

The potential effects of a low-probability, high impacts event—a VLOS (Very Large Oil Spill)—were also analyzed. To facilitate an objective and well-informed analysis, BOEMRE developed a reasonable set of specific parameters for a hypothetical VLOS scenario, and then analyzed the potential environmental impacts that could occur in the event of such a scenario.

The VLOS scenario assumes a blowout leading to a very large oil spill. In estimating the oil spill flow rate, the scenario employs a hypothetical discharge model that estimates the highest possible uncontrolled flow rate that could occur from known prospects in the proposed Sale 193 area, given real world constraints. Oil spill duration in the scenario is posited at 74 days, the estimated length of time required for a second drilling platform to arrive on scene from elsewhere in the Pacific Ocean, and then complete a relief well. A duration of 74 days is a conservative estimate—the scenario does not take into consideration the variety of other measures (i.e. well intervention, containment domes, same-vessel relief well, second vessel on-site, etc.) that could be used to stop flow within a much shorter timeframe.

Once the basic parameters (spill volume, hydrocarbon properties and persistence, etc.) of the VLOS are established, BOEMRE uses an Oil Spill Risk Analysis (OSRA) model to simulate estimated oil spill trajectories. In other words, the OSRA model estimates where the spilled oil may go, as well as how long it may take to get there, thus further informing the analysis of potential environmental effects.

In the unlikely event that a VLOS were to occur in the Chukchi Sea, the potential for significant effects on a variety of resource areas would be high. Significant adverse impacts could potentially occur (to components or species) within all examined environmental resource categories, with the exception of Terrestrial Mammals and Economy. Potential impacts for each resource area are summarized in Table ES-2 (below). The level of impacts associated with each alternative is compared to those described for the Proposed Action.

Table ES-2. New potential impacts as a result of a VLOS scenario. For each resource area, types and levels of potential impacts are described for Alternative I-Proposed Action, then impacts for Alternatives III and IV are compared with Alternative I. Alternative II-No Action would have no additional impacts on any resource area.

Resource Area	Alt. I – Proposed Action (no deferral area)	Alt. III – Corridor I (largest deferral area)	Alt. IV – Corridor II (smaller deferral area)
Water Quality	Hydrocarbon contamination would degrade water quality in violation of State and Federal criteria, thus causing significant impacts.	Deferral area would mean largest minimum distance between VLOS source and the coastline, further reducing potential for contamination of nearshore and coastal waters. Impacts to offshore water quality would remain the same as under Alt I.	Deferral area would increase the minimum distance between VLOS source and coastline as compared to Alt. 1, reducing the potential for contamination of nearshore and coastal waters. Impacts to offshore water quality would remain the same as under Alt I.
Air Quality	Significant adverse impacts to air quality would result from an initial explosion, evaporative emissions from offshore oil, and subsequent response vessels.	Potential impacts the same as those for Alt I.	Potential impacts the same as those for Alt I.
Lower Trophic-Level Organisms	A VLOS would cause acute and, for some species, significant impacts to lower trophic-level organisms and communities, and would adversely affect food webs.	Potential impacts the same as those for Alt I.	Potential impacts the same as those for Alt I.

Resource Area	Alt. I – Proposed Action (no deferral area)	Alt. III – Corridor I (largest deferral area)	Alt. IV – Corridor II (smaller deferral area)
Fish	Direct and indirect effects of a VLOS can lead to significant impacts on certain fish species. Effects on each population would depend on a variety of factors.	Deferral area would mean the largest minimum distance between VLOS source and coastline, further reducing potential for impacts to nearshore and estuarine fish, including anadromous fish. Impacts to fish in offshore areas would remain the same as under Alt I.	Deferral area would increase the minimum distance between VLOS source and coastline as compared to Alt I, reducing the potential for impacts to nearshore and estuarine fish, including anadromous fish. Impacts to fish in offshore areas would remain the same as under Alt I.
Essential Fish Habitat	EFH for Arctic cod, saffron cod, and all five species of Pacific salmon would be significantly impacted.	Deferral area would mean the largest minimum distance between VLOS source and coastline, further reducing potential for impacts to nearshore and estuarine EFH. Impacts to fish in offshore areas would remain the same as under Alt I.	Deferral area would increase the minimum distance between VLOS source and coastline as compared to Alt I, reducing the potential for impacts to nearshore and estuarine EFH. Impacts to fish in offshore areas would remain the same as under Alt I.
Cetaceans	Cetaceans could experience a variety of direct and indirect effects. Significant effects to some cetacean species (including bowhead whale) could occur under certain circumstances.	Deferral area would mean the largest minimum distance between VLOS source and coastline, further reducing the potential for impacts to species (including bowhead and beluga whales) that migrate through or otherwise use the spring lead system and/or nearshore areas. Impacts to cetaceans in offshore areas would remain the same as under Alt I.	Deferral area would increase the minimum distance between VLOS source and coastline, reducing the potential for impacts to species (including bowhead and beluga whales) that migrate through or otherwise use the spring lead system and/or nearshore areas. Impacts to cetaceans in offshore areas would remain the same as under Alt I.
Polar Bears	Polar bears could be affected by a VLOS in several ways. Polar bears are particularly sensitive to oiling. Significant impacts would occur if large numbers of polar bears are contacted or otherwise affected.	Deferral area would mean the largest minimum distance between VLOS source and coastline, further reducing the potential for impacts to polar bears using nearshore or coastal habitat. Impacts to polar bears using offshore sea ice would remain the same as under Alt I.	Deferral area would increase the minimum distance between VLOS source and coastline, reducing the potential for impacts to nearshore and coastal habitat. Impacts to polar bears using offshore area sea ice would remain the same as under Alt I.

Resource Area	Alt. I – Proposed Action (no deferral area)	Alt. III – Corridor I (largest deferral area)	Alt. IV – Corridor II (smaller deferral area)
Marine and Coastal Birds	Exposure to oil can negatively impact marine and coastal birds in a variety of ways. Those species which tend to congregate in potentially affected areas are most susceptible to significant impacts.	Deferral area would mean the largest minimum distance between VLOS source and coastline, further reducing the potential for impacts to large aggregations of birds in important nearshore or coastal areas. Impacts to birds using offshore areas remain the same as under Alt I.	Deferral area would increase the minimum distance between VLOS source and coastline, reducing the potential for impacts to large aggregations of birds in important nearshore or coastal areas. Impacts to birds using offshore areas would remain the same as under Alt I.
Ice Seals	Ice seals would experience adverse impacts from direct exposure to oil, long-term exposure to contaminants and from decreased availability of prey species. Any population-level impacts would be recovered within three generations.	Deferral area would mean the largest minimum distance between VLOS source and coastline, further reducing the potential for impacts to habitat used by spotted, bearded and ringed seals. Impacts to seals in offshore areas remain the same as under Alt I.	Deferral area would increase the minimum distance between VLOS source and coastline, reducing the potential for impacts to habitat used by spotted, bearded and ringed seals. Impacts to seals in offshore areas would remain the same as under Alt I.
Pacific Walrus	Significant impacts to walrus could occur if large scale contamination of prey and habitat persisted for years.	Deferral area would mean the largest minimum distance between VLOS source and coastline, further reducing the potential for contact with certain areas where walrus may congregate.	Deferral area would increase the minimum distance between VLOS source and coastline, reducing the potential for contact with certain areas where walrus may congregate.
Terrestrial Mammals	A VLOS could adversely impact a variety of terrestrial mammals. However, full recovery of population numbers would occur within two years.	Deferral area would mean the largest minimum distance between VLOS source and coastline, further reducing the potential for contact with terrestrial mammal habitat.	Deferral area would increase the minimum distance between VLOS source and coastline, reducing the potential for contact with terrestrial mammal habitat.
Vegetation and Wetlands	Localized but potentially long-term impacts to potentially affected vegetation and wetlands habitat. Inland and marsh areas would only be affected if the presence of spilled oil coincided with a storm surge event.	Deferral area would mean the largest minimum distance between VLOS source and coastline, further reducing the potential for contamination of nearshore, estuarine, and intertidal areas and the vegetation they support.	Deferral area would increase the minimum distance between VLOS source and coastline, reducing the potential for contamination of nearshore, estuarine, and intertidal areas and the vegetation they support.

Resource Area	Alt. I – Proposed Action (no deferral area)	Alt. III – Corridor I (largest deferral area)	Alt. IV – Corridor II (smaller deferral area)
Economy	A large scale oil spill response effort triggered by a VLOS would generate thousands of jobs and millions of dollars in income. A VLOS could also have negative impacts on potential future economic activities in the area.	Potential impacts the same as those for Alt I.	Potential impacts the same as those for Alt I.
Subsistence Harvest Patterns	A VLOS could cause significant adverse impacts by diminishing, displacing, and/or contaminating subsistence resources. Concerns about contamination could persist many years, long after actual harvest disruption.	Deferral area would mean the largest minimum distance between VLOS source and coastline, further reducing the potential for contamination of important subsistence areas along the U.S. Chukchi coast. Deferral corridor may also reduce the potential for impacts to certain resources important for subsistence.	Deferral area would increase the minimum distance between VLOS source and coastline, reducing the potential for contamination of important subsistence areas along the U.S. Chukchi coast. Deferral corridor may also reduce the potential for impacts to certain resources important for subsistence.
Sociocultural Systems	Disruption to, and displacement of, sociocultural systems would be compounded by long term impacts to subsistence resources and practices.	Deferral area would mean the largest minimum distance between VLOS source and coastline, further reducing the potential for impacts to subsistence resources and harvest areas, and therefore reducing the potential for disruption of sociocultural systems.	Deferral area would increase the minimum distance between VLOS source and coastline, reducing the potential for impacts to subsistence resources and harvest areas, and therefore reducing the potential for disruption of sociocultural systems.
Archaeological Resources	Onshore spill response and cleanup is the aspect of a VLOS with the most potential to affect archaeological resources.	Potential impacts the same as those for Alt I.	Potential impacts the same as those for Alt I.
Environmental Justice	Disproportionate high adverse environmental and health impacts to Alaska Inupiat Natives would occur via impacts to subsistence, sociocultural systems, and health.	Deferral area would mean the largest minimum distance between VLOS source and coastline, further reducing the potential for impacts to subsistence resources and harvest areas, and thereby reducing the potential for disproportionate, high impacts to Inupiat communities.	Deferral area would increase the minimum distance between VLOS source and coastline, reducing the potential for impacts to subsistence resources and harvest areas, and thereby reducing the potential for disproportionate, high impacts to Inupiat communities.

5. Cumulative Effects

Potential cumulative effects associated with natural gas development and production activities are analyzed. Each alternative is evaluated with respect to its incremental contribution to past, present, and reasonably foreseeable activities, as well its potential synergistic effects. This analysis follows a five-step process:

1. Identify potential effects that may occur in the Chukchi Sea and adjacent offshore and onshore areas.
2. Identify other past, present, and reasonably foreseeable future oil and gas development activity.
3. Consider effects on environmental resources from other actions.
4. Quantify effects by estimated extent and duration.
5. Weigh effects based on level of certainty as well as chronological and geological proximity to the Sale 193 activities.

The cumulative effects analysis includes special consideration of Arctic warming, which could contribute to cumulative effects through several factors:

- increases in noise and disturbance related to increased shipping
- decreases in ice cover resulting in changes in species distributions
- changes in subsistence-hunting practices
- northern expansion of species
- increased ocean acidity

Overall, the contribution of natural gas development and production activities to potential cumulative effects would be small. In fact, for most resource areas the incremental contribution is expected to be negligible. This is primarily due to the relatively small amount of new disturbance associated with natural gas development and production. Only in terms of impacts to local economy and state economy, and potentially subsistence-harvest patterns and sociocultural systems, would natural gas development and production contribute more than negligibly to cumulative effects. There would be a substantial incremental contribution to the local economy and a minor incremental contribution to the state economy. The proposed action would also substantially contribute to negative impacts on subsistence and sociocultural systems near Wainwright, or any other communities close to development.

Cumulative effects associated with the hypothetical VLOS scenario are discussed for each resource area within the VLOS effects analysis section, principally within respective Long-Term Recovery subsections.

6. Consultation and Coordination

BOEMRE has engaged in several consultation and coordination processes with other regulatory agencies regarding proposed activities under Sale 193. Prominent consultation and coordination processes associated with Sale 193 include:

- *Endangered Species Act - Section 7 Consultation.* For ESA consultation on proposed lease sales, BOEMRE specifically requests incremental Section 7 consultations with FWS and NMFS. During the Sale 193 process, BOEMRE has consulted with the applicable Service regarding the following endangered or threatened species: bowhead whale, humpback whale, fin whale, polar bear, spectacled eider, and Steller's eider. BOEMRE has also conferenced regarding the following proposed or candidate species: Kittlitz's murrelet, yellow-billed loon, Pacific walrus, bearded seals, and ringed seals. BOEMRE has also re-initiated consultation regarding the polar bear in light of the recent designation of critical habitat for that species.

- *Magnuson-Stevens Fishery Conservation and Management Act Consultation*. In 2006, BOEMRE completed consultation with respect to potential effects on the essential fish habitat (EFH) for all five species of Pacific salmon. Subsequent to the consultation associated with the Sale 193 FEIS, EFH was designated for three additional species in or near the action area: Arctic cod, saffron cod, and opilio crab. To address EFH consultation requirements for the upcoming decision to affirm, modify, or cancel Lease Sale 193, BOEMRE prepared and submitted an EFH assessment and formal determination to NMFS in July 2011.

- *National Historic Preservation Act - Section 106 Consultation.* BOEMRE has consulted with the Alaska State Historic Preservation Officer (SHPO) on Sale 193 and received concurrence from SHPO in March 2007. Additional consultations would occur prior to any exploration or development and production.
- *Coastal Zone Management Act Consistency Review.* After appropriate analysis, BOEMRE found Sale 193 to be consistent with the enforceable policies of the Alaska Coastal Management Program (ACMP). In October 2007, the State of Alaska issued a final consistency decision concurring with the determination that Sale 193 is consistent (to the maximum extent practicable) with the ACMP and the local district's enforceable policies. On July 1, 2011, the ACMP was allowed to sunset. With the termination of the ACMP, there are no enforceable standards on which to base a consistency review of federal coastal development activities. No State or Federal agency will take over or assume the function and responsibilities for coastal zone management in Alaska.

Appendix A. Analysis of Incomplete or Missing Information

Responding to the second and third concerns of the U.S. District Court's remand, Appendix A analyzes each statement from the Sale 193 FEIS that identifies incomplete or unavailable information. The analysis includes statements identified by the plaintiffs in litigation as well as additional statements independently identified by BOEMRE analysts for the purpose of this analysis.

Each catalogued statement underwent an objective, sequential, and robust review process developed to ensure consistency with 40 CFR 1502.22. This inquiry first asked whether the missing information was "relevant to reasonably foreseeable significant adverse effects on the human environment?" If answered in the negative, the inquiry concludes for that item and an explanation is given. If answered in the positive, the item proceeds to the next step, which asks whether the missing information is "essential to a reasoned choice among alternatives?" Again, if answered in the negative, the inquiry concludes for that item and an explanation is given. If answered in the positive, the inquiry next asks whether the missing information is obtainable. Information is considered obtainable if the overall costs of obtaining it are not exorbitant, and the means to acquire it are known.

BOEMRE analysts determined that while many statements of incomplete or unavailable information were broadly relevant to the important issues at hand, none were essential for a reasoned choice among alternatives. Because no items progressed beyond step 2 of the 1502.22 analysis, additional consideration of whether particular items of incomplete information are obtainable was not necessary.

Appendix B. Very Large Oil Spill Information

This appendix – Oil-Spill Information, Models, and Estimates – updates Appendix A of the Sale 193 FEIS with recent information regarding OCS well control incidents as well as additional information relevant to the VLOS analysis.

Appendix C. Fish Resources and EFH – Tables and Figures

This appendix contains additional tables and figures informing the analysis of fish resources and Essential Fish Habitat are provided.

Appendix D. Estimate for a Very Large Oil Spill

This appendix explains the methodology used for estimating the basic parameters (i.e. hydrocarbon composition, flow rate, spill duration, spill volume) of the VLOS scenario.

Appendix E. Responses to Public Comments

This appendix summarizes and provides responses to comments received on the Draft SEIS and Revised Draft SEIS. BOEMRE conducted a thorough review of oral testimony received at public hearings as well as each electronic or written comment received. All relevant, substantive comments are grouped within distinct issue categories. Within each issue category, specific topics are defined, comment sources are identified, and BOEMRE's response are provided.

Table of Contents

Table of Contents

List of Figures

List of Tables

Chapter I

The Proposed Action

CHAPTER I. Proposed Action

I.A. Background

This section describes the relevant events and processes that have provided context for developing this Final SEIS. On June 18, 2010, by Secretarial Order No. 3302, the USDOI, Minerals Management Service (MMS) was renamed the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE). The actions described below are attributed to either MMS or BOEMRE, as appropriate.

On June 30, 2002, the Secretary of the U.S. Department of the Interior (USDOI) approved a Final Outer Continental Shelf (OCS) Oil and Gas Leasing Program for 2002–2007 (2002–2007 Five-Year Program). In compliance with the National Environmental Policy Act (NEPA), MMS in September 2005 published a Notice of Intent to Prepare an Environmental Impact Statement analyzing a proposed lease sale known as Chukchi Sea OCS Lease Sale 193. MMS released in October 2006, a document entitled "Draft Environmental Impact Statement for Oil and Gas Lease Sale 193 and Seismic-Surveying Activities in the Chukchi Sea" (USDOI, MMS, 2006). In June 2007, the final document was released and entitled "Final Environmental Impact Statement for Oil and Gas Lease Sale 193 and Seismic-Surveying Activities in the Chukchi Sea" (Sale 193 FEIS)(USDOI, MMS, 2007a). This document is hereby incorporated by reference (USDOI, MMS, 2007a; available at http://www.alaska.boemre.gov/ref/EIS%20EA/Chukchi_FEIS_193/feis_193.htm.

The prelease process was not completed in time for Chukchi Sea OCS Lease Sale 193 to be conducted within the 2002-2007 Five-Year Program, which expired on June 30, 2007. Chukchi Sea OCS Oil and Gas Lease Sale 193 was included in the 2007-2012 Five Year Oil and Gas Leasing Program approved by the Secretary of the U.S. Department of the Interior (Secretary) on June 29, 2007.

The 2007-2012 Outer Continental Shelf Oil and Gas Program was subject to litigation in the U.S. Court of Appeals for the District of Columbia (*Center for Biological Diversity v. DOI*, Nos. 07-1247, 07-1433 [D.C. Cir.]). In April 2009 the D.C. Circuit Court found that the Environmental Sensitivity Analysis was insufficient. On July 29, 2009, the Court limited its mandate to the Beaufort, Chukchi, and Bering Sea Planning Areas. In response, the Department conducted a more complete environmental sensitivity analysis beyond the shoreline that compares the environmental sensitivity of all 26 OCS planning areas and identifies those areas whose environments are most and least sensitive to OCS activity. After reviewing the new analysis and rebalancing the factors required by the OCS Lands Act, the Secretary announced the Preliminary Revised Program (PRP) for 2007-2012 on March 31, 2010, which included a sale in the Chukchi Sea Planning Area. The Department submitted the PRP to the Court, President, and the Congress, and announced a 30-day public comment period closing on May 3, 2010. During the comment period, the Department received over 118,000 comments for the Secretary's consideration. On December 23, 2010, the Secretary submitted the Revised Program to the Court. The Revised Program superseded the original program decision made in 2007. Sale 193 remained in the Five-Year Program as did a special interest sale in Cook Inlet. The North Aleutian Basin Sale 214, Beaufort Sea Sales 209 and 217, and Chukchi Sea Sales 212 and 221, were removed from the Revised Program. On March 4, 2011, the government filed a motion with the court to dismiss the case. On April 26, 2011, the Court issued an Order acknowledging that no party had opposed dismissal or challenged the Secretary's Revised Program, and requiring that its mandate, previously stayed, be issued. The mandate, issued on May 5, 2011, vacated the original 2007-2012 Program, leaving the unchallenged 2007-2012 Revised Program in its place. The parties filed a motion with the Court to dismiss the case.

In January 2008, the MMS issued a Final Notice of Sale for Chukchi Sea OCS Oil and Gas Lease Sale 193 to be conducted in February 2008. On January 31, 2008, a lawsuit was filed alleging violations pursuant to NEPA and the Endangered Species Act [*Native Village of Point Hope v. Salazar*, No. 1:08-cv-00004-RRB (D. Alaska)]. Plaintiffs in the case included Native Village of Point Hope, the City of Point Hope, the Iñupiat Community of the Arctic Slope, REDOIL, the Alaska Wilderness League, Center for Biological Diversity, National Audubon Society, Natural Resources Defense Council, Northern Alaska Environmental Center, Oceana, Pacific Environment, Sierra Club, and The Wilderness Society. Sale 193 was held in February of 2008. MMS received high bids totaling approximately $2.6 billion and issued 487 leases, covering approximately 2.8 million acres.

On July 21, 2010, two years after the lawsuit was filed, the United States (U.S.) District Court for the District of Alaska (District Court) issued an Order remanding the Sale 193 matter to BOEMRE (formerly MMS) to satisfy its obligations under NEPA in accordance with the District Court's opinion. This District Court's Order was amended on August 5, 2010, and guidelines for compliance with the Order were established by the Court on September 2, 2010.

Pursuant to the amended Order, BOEMRE was instructed to address three concerns, as follows:

- Analyze the environmental impact of natural gas development.
- Determine whether missing information identified by BOEMRE in the Sale 193 FEIS was essential or relevant under 40 CFR 1502.22.
- Determine whether the cost of obtaining the missing information was exorbitant, or the means of doing so unknown.

On October 5, 2010, BOEMRE issued a Notice of Intent to Prepare a Supplemental Environmental Impact Statement: Outer Continental Shelf, Alaska OCS Region, Chukchi Sea Planning Area, Oil and Gas Lease 193. On October 15, 2010, a Draft Supplemental Environmental Impact Statement (Draft SEIS) was released to the public for a 45-day comment period ending November 30, 2010. In November 2010, BOEMRE held public hearings and government-to-government consultations with affected tribes. By the end of the public comment period, BOEMRE Alaska OCS Region received over 150,000 comments on the Draft SEIS, some of which raised matters requiring significant technical review. Many commenters requested that BOEMRE perform an analysis that takes into account the possibility of a blowout during exploration activities, in view of the *Deepwater Horizon* event (DWH event).

Neither the Sale 193 FEIS (May 2007) nor the Draft SEIS (October 2010) analyzed a Very Large Oil Spill (VLOS)—that is, a spill more than or equal to 150,000 barrels of oil. The Sale 193 FEIS did analyze a large spill from hypothetical development activities of 1,500 barrels from a platform or 4,600 barrels from a pipeline. The Draft SEIS (October 2010) was predicated on the District Court's remand order of July 21, 2010.

The DWH event, however, caused BOEMRE to reassess the likelihood of an exploration well blowout and VLOS. Subsequent to releasing the Draft SEIS and receiving public comments, BOEMRE completed an analysis of possible flow rates throughout the most prospective locations in the Chukchi Sea Lease Sale 193 area. This analysis determined a high possible flow rate that, unimpeded, could result in an oil spill volume much larger than had been analyzed in the Sale 193 FEIS. In March 2011, BOEMRE announced a decision to incorporate a VLOS analysis into its ongoing SEIS process. The VLOS analysis is based on the estimated size of an unlikely but possible oil spill resulting from a hypothetical blowout scenario. Further discussion of the estimate for a VLOS event from an exploration well is provided in Appendix D. To ensure sufficient opportunity for public and agency comment on its VLOS analysis, BOEMRE decided to issue a Revised Draft SEIS.

This Revised Draft Supplemental EIS augmented the analysis of the Sale 193 FEIS to address the District Court's remand and to analyze the potential environmental impacts of VLOS. The Revised Draft SEIS relied on the existing analysis provided by the Sale 193 FEIS where appropriate, added new analysis with respect to the District Court's three concerns (including analysis of natural gas development), and analyzed a hypothetical VLOS scenario. The Revised Draft SEIS also included revisions that responded to comments received on the Draft SEIS.

On May 19, 2011, the District Court issued another order directing the Department and BOEMRE to modify their schedule to conclude the supplemental environmental impact statement process and have a Secretarial decision regarding Sale 193 by October 3, 2011.

On May 27, 2011, the Revised Draft SEIS was released to the public with a 45 day public comment period ending July 11, 2011. In June 2011, BOEMRE held public hearings in Alaska communities and government-to-government consultations with affected tribes. By the end of the comment period BOEMRE received approximately 360,000 comments from various entities: Federal, State and local governments; organizations; tribes; corporations, nongovernmental, industry, business and trade organizations; members of the Alaska State legislature; members of other state legislatures; and the public at large. These comments were then considered when preparing the Final SEIS.

In preparing the Sale 193 Final SEIS, BOEMRE has responded to the public comments and considered information from the USGS report "An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas, Alaska" (USGS, 2011) wherever relevant to understanding the potential environmental impacts of each lease sale alternative. The Final SEIS satisfies the concerns addressed by the District Court in its remand order, provides a comprehensive VLOS analysis, and provides the Secretary with sufficient information to affirm, modify, or cancel the Department's previous decision on Sale 193.

In accordance with Council on Environmental Quality (CEQ) regulations and guidelines, BOEMRE also intends that further analysis of specific proposed activities may tier from this Final SEIS, such that the facts and analysis presented in this Final SEIS may be incorporated by reference into future, proposal-specific environmental reviews.

I.B. Purpose and Need for the Proposed Action

The purpose of the proposed action addressed in the Sale 193 FEIS and the Sale 193 Final SEIS is to (1) offer for lease areas in the Chukchi Sea Planning Area (see Figures 1 and 4) of the Alaska Outer Continental Shelf (OCS) that might contain economically recoverable oil and gas resources and (2) provide analyses for exploration seismic-survey activities. The Final SEIS augments the analysis in the Sale 193 FEIS by analyzing the potential environmental impact of natural gas development, evaluating (in Appendix A) incomplete, missing, or unavailable information pursuant to 40 CFR 1502.22, and analyzing the environmental impact of a low probability VLOS event. The Final SEIS, together with the Sale 193 FEIS, provides the Secretary with sufficient information to affirm, modify, or cancel the Department's previous decision on Sale 193.

The Outer Continental Shelf Lands Act of 1953 (OCSLA), as amended (43 U.S.C. 1331 et seq. [2008]), established federal jurisdiction over submerged lands seaward of state boundaries. Under the OCSLA, the Department of the Interior is required to manage the leasing, exploration, development, and production of oil and gas resources on the Federal OCS. The Secretary develops the five-year OCS oil and gas program and is required to balance orderly resource development with protection of the human, marine, and coastal environments while simultaneously ensuring that the public receives an equitable return for these resources and that free-market competition is maintained. The OCSLA empowers the Secretary to grant leases to the highest qualified responsible bidder(s) on the basis of sealed competitive bids and to formulate such regulations as necessary to carry out the provisions of the Act. The Secretary has designated BOEMRE as the agency responsible for the mineral leasing of submerged OCS lands and for the supervision of offshore operations after lease issuance, in accordance with the provisions of the OCSLA.

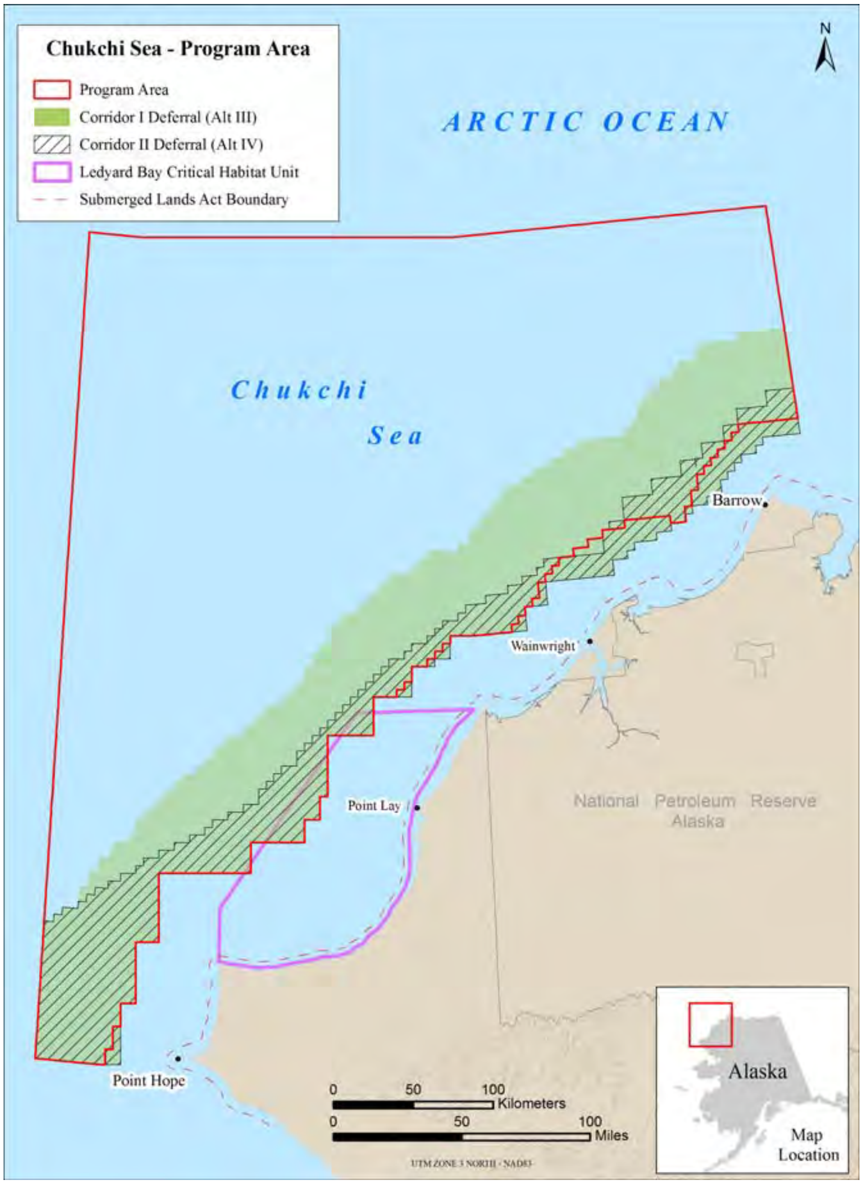

Figure 1. Program Area, excluding sale blocks within a 25-mile coastal buffer (deferred in the 2007–2012 Five-Year Program). Corridor I and Corridor II deferrals for Alternatives III and IV, respectively, and Ledyard Bay Critical Habitat Unit for spectacled eider are also shown.

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. BOEMRE's current petroleum assessment indicates a mean technically recoverable oil resource of 15 billion barrels (Bbbl) with a 5% chance of 40 Bbbl (USDOI, MMS, 2006). The mean undiscovered gas resources total 76.77 trillion cubic feet (Tcf) with a 5% chance of 209.53 Tcf. At these levels, the leasing of offshore areas within the Chukchi Sea may lead to development and production, and could contribute significantly to the national energy supply.

I.C. Description of the Proposed Action

The proposed action is to affirm the issuance of leases pursuant to the Chukchi Sea OCS Oil and Gas Lease Sale 193, as analyzed in "Final Environmental Impact Statement for Oil and Gas Lease Sale 193 and Seismic-Surveying Activities in the Chukchi Sea" (Sale 193 FEIS)(USDOI, MMS, 2007a).

The proposed action (Program Area) encompasses approximately 6,156 whole and partial blocks (about 34 million acres) within the Chukchi Sea portion of Alaska's OCS (Figure 1). In the 2007-2012 Five-Year Program, the Secretary excluded from the sale a corridor near the State of Alaska's northern coast, a distance of up to approximately 25 miles from shore. 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.

After releasing the Sale 193 FEIS in June 2007, BOEMRE held Sale 193 in February of 2008. BOEMRE received high bids totaling approximately $2.6 billion and issued 487 leases (see lease blocks in Figure 2), covering approximately 2.8 million acres.

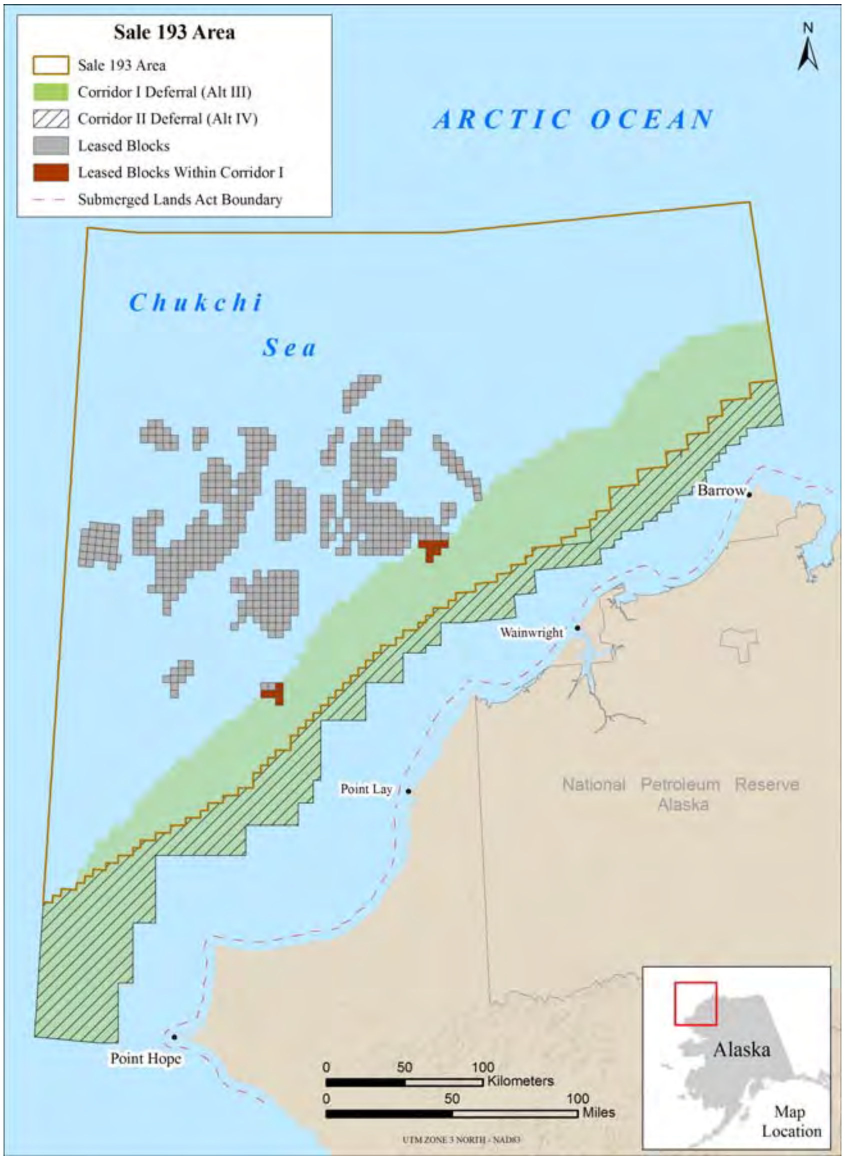

Figure 2. The Sale 193 Area is illustrated with a tan border—it excludes sale blocks within a 25-mile coastal buffer (deferred in the 2007–2012 Five-Year Program). This area reflects the selection of Alternative IV (which incorporates the Corridor II Deferral). Also illustrated are the leased tracts from Sale 193.

I.D. Regulatory and Administrative Framework

Federal laws establish the OCS leasing program (i.e., Outer Continental Shelf Lands Act) and the environmental review process (i.e., NEPA). Several Federal statutes and their implementing regulations establish specific consultation and coordination processes with Federal, State, and local agencies (i.e., Coastal Zone Management Act [CZMA], National Historic Preservation Act [NHPA], Endangered Species Act [ESA], the Magnuson-Stevens Fishery Conservation and Management Act, and the Marine Mammal Protection Act [MMPA]). 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.

A complete treatment of the regulatory and administrative framework can be reviewed in the Sale 193 FEIS (available online at http://www.alaska.boemre.gov/ref/EIS%20EA/Chukchi_FEIS_193/feis_193.htm), in the 2007-2012 Five-Year Program EIS (available online at http://www.boemre.gov/5-year/2007-2012FEIS/Intro.pdf), and in the Arctic Multi-Sale Draft EIS (available online at http://alaska.boemre.gov/ref/EIS%20EA/ArcticMultiSale_209/2008_0055_deis/vol1.pdf).

I.D.1. Outer Continental Shelf Lands Act

Under the OCSLA, 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 following: the protection of the human, marine, and coastal environments; a fair and equitable return for OCS resources; and maintenance of free market competition in the leasing process. The OCSLA also requires coordination with affected states, as well as local governments, affected by OCS development activities. BOEMRE seeks and encourages participation from affected states and other interested parties at each procedural step leading to lease issuance.

The OCSLA creates a four-stage process for planning, leasing, exploration, and production of oil and gas resources in Federal waters (see Figure 3). In the first stage, the Secretary (through BOEMRE) prepares a five-year leasing program to identify the size, timing, and location of proposed lease sales, and prepares an environmental document under NEPA. In the second stage, BOEMRE conducts the prelease process for sale-specific NEPA reviews. If BOEMRE proceeds with a sale, BOEMRE conducts a sealed-bid auction, opens the bids it receives, evaluates the bids for fair market value, and issues the leases. Under the four-stage process, an OCS lease authorizes a lessee to engage only in “ancillary activities” that receive further environmental review to determine if they will cause any harm to the environment and are only approved if the activity does not cause “undue or serious harm or damage to the human, marine, or coastal environment” (30 CFR 250.105, 250.202, and 250.209; see also, 43 U.S.C. 1340[c][approval required prior to exploration]; 43 U.S.C. 1351 [approval required prior to development and production]). The Supreme Court has recognized that “[u]nder OCSLA’s plain language, the purchase of a lease entails no right to proceed with full exploration, development, or production…; the lessee acquires only a priority in submitting plans to conduct these activities" (*Secretary of the Interior v. California*, 464 U.S. 312, 339 [1984]). The third stage involves exploration of the leased tracts. Prior to any exploratory drilling, a lessee must submit an exploration plan (EP) to BOEMRE for review and approval. The EP must comply with the OCSLA, implementing regulations, lease provisions, and other Federal laws, and is subject to environmental review under NEPA. BOEMRE must not approve an EP if the proposed activities would cause “undue or serious harm or damage to the human, marine, or coastal environment.” If the EP is approved, the lessee must also apply for specific permits needed to conduct the activities as described in the EP. The fourth stage, development, is reached only if a lessee finds a commercially viable oil and/or gas discovery. A lessee must submit a detailed development and production plan (DPP) that BOEMRE must review under NEPA. If the DPP is approved, the lessee must also apply for specific pipeline, platform, and other permits for approval.

The OCSLA four-stage oil and gas review process gives the Secretary a "continuing opportunity for making informed adjustments" in developing offshore energy resources to ensure all activities are conducted in an environmentally sound manner (*Sierra Club v. Morton*, 510 F.2d 813, 828 [5th Cir.1975]).

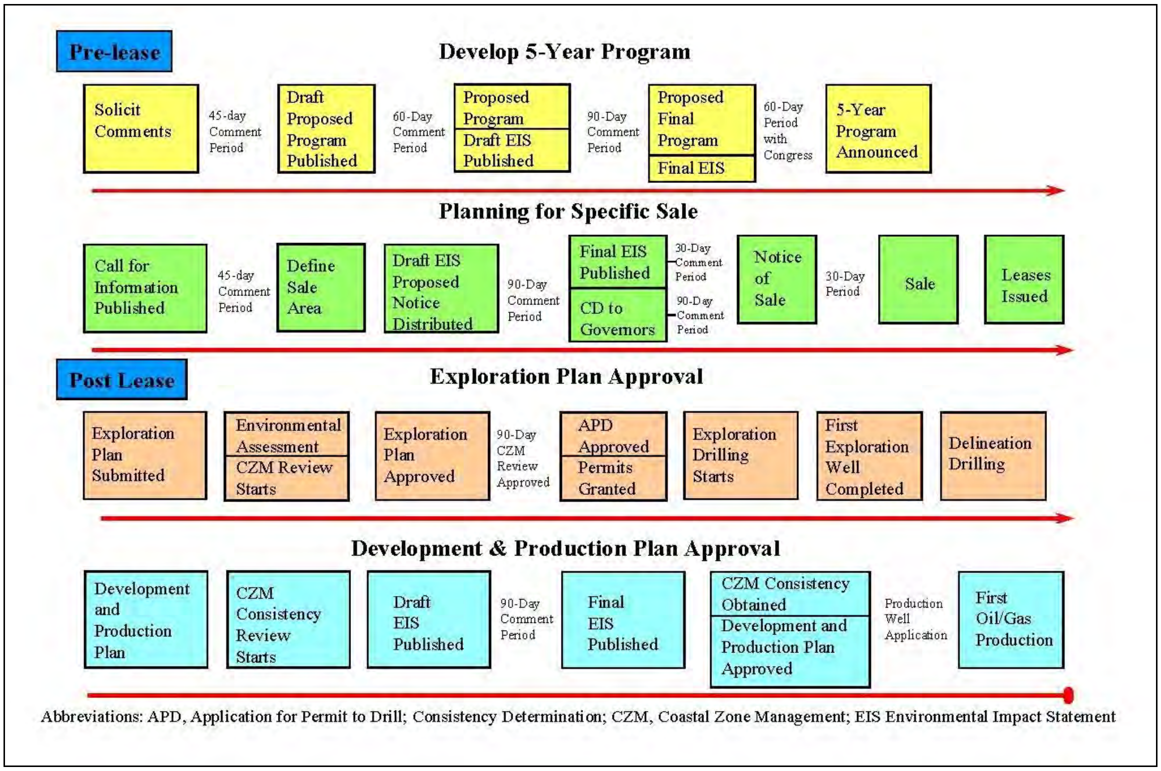

Figure 3. Four stages of the Outer Continental Shelf Lands Act (OCSLA) oil and gas process.

I.D.2. National Environmental Policy Act and Council on Environmental Quality

The National Environmental Policy Act (42 USC 4321 et seq.) requires Federal agencies to use a systematic, interdisciplinary approach to protecting the human environment. This approach ensures the integrated use of the natural and social sciences in any planning and decision-making that may have an impact on the environment. In furtherance of these policies, NEPA also requires Federal agencies to prepare a detailed EIS on any major Federal action that may have a significant impact on the environment. This EIS must analyze any adverse environmental effects that cannot be avoided or mitigated, alternatives including 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 NEPA. These regulations (40 CFR 1500.1–1508.28) provide for the use of the NEPA process to identify and assess the alternatives to proposed actions that avoid and minimize adverse effects on the human environment. The DOI regulations implementing NEPA are at 43 CFR Part 46.

I.D.3. Land Use and Coastal Management

Land Status and Use

This section describes the status of land adjacent to the U.S. Chukchi Sea. The land adjacent to the U.S. Chukchi Sea is within the North Slope Borough (NSB), a political subdivision of the State of Alaska. Land-ownership in the NSB is complex. The Federal Government is the predominant land owner of onshore lands, with more than half of the Borough's land area encompassed by the National Petroleum Reserve-Alaska (NPR-A) and the Arctic National Wildlife Refuge (ANWR). Other major landholders include the State of Alaska, Arctic Slope Regional Corporation (ASRC), Nunamuit Corporation, Atqasuk Corporation, Ukpeagvik Iñupiat Corporation, Kaktovik Iñupiat Corporation, Kuukpik Village Corporation, Tikigaq Corporation, Cully Corporation, and Olgoonik Corporation.

Coastal Zone Management

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 post-lease 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. However, the State of Alaska did not pass legislation required to extend the Alaska Coastal Management Program (ACMP), allowing the ACMP to sunset at 12:01 AM, Alaska Standard Time, on July 1, 2011. With the termination of the ACMP, there are no enforceable standards on which to base a consistency review of federal coastal development activities. No State or Federal agency will take over or assume the function and responsibilities for coastal zone management in Alaska.

I.D.4. Notices and Information Provided to Lessees

To encourage lessees' knowledge and appreciation of environmental resources, to inform lessees on how to avoid adverse impacts to these resources, and to provide guidance to lessees on how to fulfill the requirements of the OCS operating regulations, BOEMRE develops and distributes the following administrative documents. Additional information on these topics is available in Section II.B.3(c)(2) and II.B.3(c)(3) of the Sale 193 FEIS.

Notice to Lessees

Notices to Lessees (NTL) inform lease owners/operators that they must meet the provisions of the regulations and how they are to operate under applicable OCS operating regulations. NTLs are either applicable nationally to the OCS program or are issued by and applicable to specific regions of the OCS. The National NTLs are posted to BOEMRE's website at http://www.boemre.gov/ntls/. The Alaska OCS Region NTLs are posted to the Alaska OCS Region's website: http://alaska.boemre.gov/regs/NTLS.htm. New NTLs issued subsequent to the *Deepwater Horizon* (DWH) event are discussed in Section IV.D.1 of this Final SEIS and are also available on BOEMRE's website.

Information to Lessees

The Information to Lessee and Operators (ITL) provides lessees with additional information on how to mitigate potential adverse impacts from future oil and gas activities. Some ITLs provide information about issues and concerns related to particular environmental or sociocultural resources. Others provide information on how lessees might plan their activities to meet BOEMRE requirements or reduce potential impacts. Still other ITLs 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, they are effective in lowering potential impacts. The ITLs listed below apply to all OCS activities in the Chukchi Sea and are considered part of the Proposed Action and each action alternative. Section II.B.3.c(3) of the Sale 193 FEIS provides the full text and discussion of each ITL listed below.

- No. 1 –Community Participation in Operations Planning
- No. 2 –Bird and Marine Mammal Protection
- No. 3 –River Deltas

- No. 4 –Endangered Whales and MMS Monitoring Program
- No. 5 –Availability of Bowhead Whales for Subsistence-Hunting Activities
- No. 6 –High-Resolution Geological and Geophysical Survey Activity
- No. 7 –Spectacled Eider and Steller's Eider
- No. 8 –Sensitive Areas to be Considered in Oil-Spill-Response Plans
- No. 9 –Coastal Zone Management
- No. 10 –Navigational Safety
- No. 11 –Offshore Pipelines
- No. 12 –Discharge of Produced Waters
- No. 13 –Use of Existing Pads and Islands
- No. 14 –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

Since the publication of the Sale 193 FEIS, there have been a couple of changes to the ITLs for the lessees. Notably, the polar bear was listed as Threatened under the Endangered Species Act in May 2008 as contemplated by ITL No. 15. Following the listing, BOEMRE reinitiated consultation with U.S. Fish and Wildlife Service. As stated in the ITL, BOEMRE has undergone consultation with FWS. For more information see Section VI.

The Final Notice of Sale included ITL No. 25, Review of Development and Production Plans. This ITL was added to fully inform lessees that BOEMRE would be conducting additional National Environmental Policy Act reviews on any proposed sale-related development. Among other things, the ITL informs lessees that any future development plan and environmental impact analyses must include information demonstrating that the structures and associated infrastructure proposed are necessary and that no other reasonable alternative sizing, placement, or grouping of this infrastructure would result in a smaller environmental footprint or cause less interference with other significant uses of the OCS and the adjacent coastal area.

Also, ITL 25 contains several lessee advisories requested by the State of Alaska. BOEMRE now advises lessees of certain information that the State of Alaska may require from them for OCS related operations that extend into State waters or that affect coastal resources and uses when the State reviews the DPP's. This may include biological surveys to identify environmentally sensitive areas; a plan to protect environmentally sensitive areas to comply with the State's oil discharge prevention and contingency plan regulations; additional lessee training on Alaska's oil spill prevention standards; adherence to the oil pollution prevention regulations of the State of Alaska; and pre-booming requirements for transfers of fuel, crude oil, persistent product, and oily ballast for all vessels operating in Alaska State waters. The ITL is provided to lessees for their planning purposes. The

Final Notice of Sale provides the full text of this ITL at: http://www.alaska.boemre.gov/cproject/Chukchi193/FNOS193/FNOS193.htm.

I.E. Prelease Processes and Activities

A full history and description of the prelease process for Sale 193 is provided in Section I.D. of the Sale 193 FEIS. Moreover, provisions specific to leasing are in 30 CFR 256, 30 CFR 259, and 30 CFR 260. Regulations concerning the Federal leasing of mineral resources are in relevant portions of 30 CFR 200 through 699. Provisions specific to offshore leasing programs are in Subchapter B of that title, i.e. 30 CFR 250–282.

I.F. Postlease Processes and Activities

BOEMRE is responsible for regulating and monitoring the oil and gas operations (and energy development in general) on the Federal OCS. Its authority extends over all operations conducted under the lease, right of use and easement, or USDOI pipeline right-of-way. BOEMRE's duties also include promoting orderly exploration, development, and production of mineral resources, while preventing harm or damage to, or waste of, any natural resource, any life or property, or the marine, coastal, or human environment. Regulations applicable to oil, gas, and sulfur lease operations on the OCS are specified in 30 CFR 250. Regulations for geological and geophysical (G&G) exploration operations on the OCS (on unleased lands or lands under lease to a third party) are specified in 30 CFR 251. Oil-spill prevention and response rules are specified in 30 CFR 254. Additional rulemaking initiated subsequent to the DWH event are discussed in Section IV.D.1 of this Final SEIS. Note that additional regulations administered and enforced by agencies other than BOEMRE also apply to OCS activities. A pertinent example includes U.S. Environmental Protection Agency (USEPA) regulations (40 CFR 125) regarding discharge and pollution, as well as the myriad regulatory regimes identified in Section I.D. of this Final SEIS.

The following subsections briefly describe several means through which BOEMRE regulates OCS post-lease activities. For a full discussion of post-lease processes please refer to Sale 193 FEIS, Section I.E. (incorporated by reference).

I.F.1. Ancillary Activities

BOEMRE regulations at 30 CFR 250.207 define the "ancillary activities" that are allowed to proceed on the OCS without the requirement of a separate permit. Information from ancillary activities is required to support review and mitigation measures for OCS exploration and development plans, and applications for pipeline rights-of-way. Shallow-hazards and site-clearance surveys are used to identify and characterize potentially hazardous conditions at or below the seafloor. They also identify potential benthic biological communities (or habitats) and archaeological resources. Geotechnical activities obtain physical and chemical data on surface and subsurface sediments.

Parties seeking to conduct ancillary activities must notify BOEMRE. Proposed ancillary activities are reviewed for compliance with the performance standards listed in 30 CFR 250.202(a), (b), (d), and (e).

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

BOEMRE approval is required prior to any exploration, development, or production activities within a lease block. Lessees seeking to engage in such actions must submit for BOEMRE review an exploration plan or a development and production plan, as appropriate. Proposed plans must include supporting information such as environmental information, an archaeological report, a biological report in accordance with 30 CFR 250 (monitoring and/or live-bottom survey), and other environmental data determined necessary. This information includes an analysis of both offshore and onshore impacts that may occur as a result of the activities. BOEMRE reviews supporting information for the occurrence of geo-hazards, man-made hazards, archaeological resources, or benthic communities at the proposed activity site, and evaluates potential effects on the environment. To this end, the Alaska OCS Region of BOEMRE prepares an Environmental Assessment (EA) and/or an Environmental Impact Statement (EIS) based on available information, which may include the geophysical report, archaeological report, and air-emissions data. As part of the review process, the plan and supporting environmental information are sent to the affected state(s) for consistency review and determination with respect to that state's approved Coastal Zone Management Plan (but see section I.D.3, above, for an explanation of the recent termination of the Alaska Coastal Management Program). Proposed plans are evaluated for compliance with applicable regulations, lease stipulations, and other requirements, including the adequacy of the related oil-spill response plan.

Prior to conducting drilling operations, the operator is required to submit and obtain approval for an Application for Permit to Drill (APD). The APD must include detailed information on the seafloor and shallow seafloor conditions of the drill site and detailed information about the drilling program for BOEMRE's evaluation of operational safety and pollution-prevention measures. The lessee must specify the best available and safest technology that will be used to minimize the potential for uncontrolled well flow.

As further discussed in Section IV.D.1 of this Final SEIS, new rulemaking initiated subsequent to the DWH event, as well as new NTLs issued in recent months, augment prior regulatory requirements for Exploration Plans, Development and Production Plans and permitting on the OCS.

I.F.3. Pipeline Regulations

Regulatory authority over pipelines on the OCS and in coastal areas is shared by several Federal agencies, including USDOI (which includes BOEMRE), the U.S. Department of Transportation, the U.S. Army Corps of Engineers, the Federal Energy Regulatory Commission, and the U.S. Coast Guard. The U.S. Fish and Wildlife Service reviews applications for pipelines that are near certain sensitive biological communities. State of Alaska standards and regulations would also come into play when OCS pipelines tie into onshore facilities, pump stations, or pipelines.

BOEMRE regulations pertaining to pipelines are at 30 CFR 250.1000–250.1019. Pipeline permit applications to BOEMRE include the pipeline location drawing, profile drawing, safety schematic drawing, pipe-design data to scale, a shallow-hazard-survey report, and an archaeological report. BOEMRE evaluates the design and fabrication of the pipeline and prepares and analysis of potential environmental impacts in accordance with applicable policies and guidelines. The Alaska OCS Region of BOEMRE prepares an EA and/or an EIS on all pipeline rights-of-way, including those that go ashore. The operators are required to periodically inspect their routes by methods prescribed by the BOEMRE 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, in-line inspection tools (smart pigs), external hydrocarbon-vapor detection (leak-detection system), and pressure analysis. 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. An abandoned pipeline would have to be flushed and cleaned to assure no residual hydrocarbon posed a risk to the environment.

I.F.4. 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, Oil Spill Response Plans (OSRPs), pollution-control equipment, and specifications for platform/structure designs.

I.F.5. BOEMRE 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 BOEMRE for review and approval.

Production-safety equipment used on the OCS must be designed, installed, used, maintained, and tested in a manner that ensures 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. “Incapable of flowing” means that in order to produce hydrocarbons from the well, artificial means would be required using mechanical pumps. 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.F.6. Pollution Prevention and Oil-Spill Response

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

In compliance with 30 CFR 254, all owners and operators of oil-handling, oil-storage, or oil-transportation facilities located seaward of the coastline must submit an OSRP to BOEMRE 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 with 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. As a general rule, OSRPs must be updated and re-submitted for BOEMRE approval every two years. Revisions to a response plan must be submitted to BOEMRE 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 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.

For more detailed discussion on pollution prevention, oil spill response plans, and oil spill response, the reader is referred to Section 4.3.3 of the Arctic Multi-Sale Draft EIS (USDOI, MMS, 2008a).

I.F.7. BOEMRE Inspection Program

Under the direction of the OCS Regional Office in Anchorage, Alaska, BOEMRE inspection program for Alaska provides review and inspection of oil and gas operations. BOEMRE conducts on-site inspections to ensure compliance with lease terms, Notices to Lessees, 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 Office Potential Incident of Noncompliance List* (USDOI, MMS, 2005).

The purpose of the inspection program is to ensure that an oil and gas facility complies with the regulations and that the lessee is conducting operations in accordance with the regulations and approved permit. BOEMRE expects to maintain a near continuous inspection presence during exploratory drilling activities. This is due to heightened public interest in the activity and the logistics for rotating inspection personnel to remote exploratory drilling locations. In the event of a discovery and subsequent development, BOEMRE will develop an inspection strategy commensurate with the scope and nature of such activities—the Alaska OCS Region conducts inspections of existing development and production facilities 3–4 times a year. Regardless whether the activity is exploration or development, BOEMRE will also conduct on-site inspections of all critical operations, including testing of blowout preventer (BOP) equipment, running and cementing casing, and well testing. The Alaska OCS Region has the authority and will issue an incident of non-compliance (INC; a documented and recordable action) when a violation is found and can shut-in (deactivate a piece of equipment or shut-down the offshore facility) any activity that is not in compliance with regulations or the approved permit. An activity that has been issued an INC or a shut-in may not restart until the Alaska OCS Region has inspected and confirmed that the non-compliance or the shut-in has been properly corrected.

BOEMRE has taken steps to further strengthen its inspection program in light of the DWH event. Moreover, BOEMRE is hiring additional inspectors and will use multiple-person inspection teams for offshore oil and gas inspections. The new process will allow teams to inspect multiple operations simultaneously and will enhance the quality of inspections on larger facilities. BOEMRE inspectors will ensure offshore operators are complying with Federal regulations and are conducting their operations in a safe and environmentally responsible manner. Also, in April 2011 the bureau created for the first time a National Offshore Training Center led by a training director, and has developed a formal training curriculum. An initial introductory course for new inspectors was held for 13 new BOEMRE inspectors and additional courses are being developed to cover specific areas of offshore inspections. In the past, BOEMRE inspectors learned how to do their jobs through a combination of on-the-job training and industry-sponsored courses aimed at teaching how certain types of equipment functioned. Inspectors also received training from academia and third-party vendors. The bureau did not previously have a training center dedicated to training inspectors on how to do their jobs. The Director of the National Offshore Training Center will develop national training strategies and programs to maintain and improve the technical capabilities of offshore inspections and compliance personnel throughout the bureau.

I.F.8. 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 leased area (30 CFR 250.1700–250.1754). BOEMRE requires lessees to submit a procedural plan for site-clearance verification. Lessees must ensure all objects related to their activities are removed following termination of their lease.

I.F.9. Training Requirements for Offshore Personnel

Proper training is important for ensuring that offshore oil and gas operations are carried out in a manner that emphasizes operational safety and minimizes the risk of environmental damage. Industry offshore personnel are required to have well control and production safety training (30 CFR 250.1500-1510).

I.G. New Information and Analysis Provided by this SEIS

This section describes three categories of new information and analysis that are included in the Final SEIS: the requirements of a U.S. District Court for the District of Alaska remand order (District Court Remand); a Very Large Oil Spill analysis; and the June 2011, U.S. Geological Survey report.

I.G.1. District Court Remand

Chukchi Sea Lease Sale 193 was held in February 2008, with BOEMRE accepting high bids of approximately $2.6 billion and issuing 487 leases for approximately 2.8 million acres. As a result of a lawsuit challenging the sale, the U.S. District Court for the District of Alaska remanded Sale 193 for further NEPA analysis of three concerns.

First, the District Court found that BOEMRE's NEPA process lacked sufficient analysis on the "environmental impacts of natural gas developments, despite industry interest and specific lease incentives for such development." In accordance with the District Court remand, this Final SEIS provides within Section IV.B and IV.C an in-depth analysis of the most viable natural gas development and production scenario for Chukchi Sea leases.

The second and third concerns both stem from the District Court's finding of procedural deficiencies in BOEMRE's treatment of missing or incomplete information within the Sale 193 FEIS. The District Court held that in order to comply with 40 CFR 1502.22, BOEMRE must determine whether missing information is relevant or essential, and whether the cost of obtaining the missing information is exorbitant, or the means of doing so is unclear. Appendix A catalogues all statements within the Sale 193 FEIS that identified incomplete, missing, or unavailable information, and performs the evaluation required by 40 CFR 1502.22.

In conducting this extensive evaluation effort, BOEMRE analysts determined that while many items of incomplete, missing, or unavailable information were broadly relevant to the important issues at hand, none were essential for a reasoned choice among alternatives. There were several reasons why the missing information cited was not deemed essential. Those reasons were inherent in the information collection and evaluation process and, therefore, were often common to many instances where missing information was noted. These reasons are listed below and explained in detail in Appendix A.

Recurring reasons why missing information is not essential to a reasoned choice among alternatives under 40 CFR 1502.22 include:

- The availability of sufficient information to support sound scientific judgments and reasoned managerial decisions, even without the identified incomplete, missing, or unavailable information.
- The presumption that adverse effects would certainly occur under the specific circumstance to which the incomplete information applies.
- The commonality of potential impacts and their severity among all action alternatives, which substantially reduced the utility of incomplete information to the decision-maker.
- The existence of other environmental laws and regulations that would preclude significant adverse effects on particular resources.
- The understanding that certain items of presently missing or incomplete information will be known (and utilized to avoid or minimize adverse impacts) at a later stage of OCSLA environmental review, when the information could potentially become essential (Village of False Pass v. Clark, 733 F.2d 605 [9th Cir. 1984]).

I.G.2. Very Large Oil Spill Analysis (VLOS)

The Final SEIS supplements the Sale 193 FEIS (MMS, 2007) by analyzing a low probability, high impact event—a hypothetical VLOS occurring during exploration activities in the Chukchi Sea Planning Area. Section IV.D provides up-to-date information on all pertinent issues, including potentially affected environmental resources, well control incident data, and the regulation of OCS activities. This Section also describes a hypothetical VLOS scenario to provide a basis for the VLOS environmental effects analysis in Section IV.E.

I.G.3. U.S. Geological Survey (USGS) Report

In March 2010, the Secretary of the Interior announced a "Comprehensive Strategy for Offshore Oil and Gas Development and Exploration." In his announcement, the Secretary asked the USGS "to assess what information is known and not known about resources, risks, and environmental sensitivities in Arctic areas." In April 2010, the Secretary announced the Department's strategy for gathering environmental, ecological, and technical information to inform decisions on oil and gas development in the Beaufort and Chukchi seas in the Arctic Ocean. The Secretary tasked USGS with completing a special review of information about the Beaufort and Chukchi seas. Specifically, the USGS report "will examine the effects of exploration activities on marine mammals; determine what research is needed for an effective and reliable oil spill response in ice-covered regions; evaluate what is known about the cumulative effects of energy extraction on ecosystems and other resources of interest; and review how future changes in climate conditions may either mitigate or compound the impacts from Arctic energy development" (USDOI, 2010). The area of study included the Chukchi and Beaufort Seas Planning Areas and the 2007–2012 Program Areas, as illustrated in Figure 4 (below). On June 23, 2011, USGS released its report: "An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas, Alaska" (USGS, 2011). The report summarizes key existing scientific information, develops a rapid process to identify where knowledge gaps exist, and provides initial guidance for what research is needed to improve decision making.

Special consideration is given in the report to four identified "Issue Topics":

- Effects of climate change on physical, biological and social conditions as well as resource management strategies in the Arctic.
- Developing foundational geospatial data on the Arctic OCS.
- Synthesis of existing scientific information on a wide range of topics.
- Spill-risk evaluation and response, and improving environmental data inputs for spill models.

Independent of the development of the USGS report, BOEMRE has already begun or planned a large number of studies that address the knowledge "gaps" in these four topics. The USGS report is generally consistent with the strategic planning undertaken by the BOEMRE Environmental Studies Program (ESP). It serves to validate BOEMRE's annual review of available data and knowledge gaps, which identifies studies for funding through the BOEMRE ESP at the National and Regional levels. Alaska OCS Region ESP information is at: http://alaska.boemre.gov/ess/index.HTM.

In preparing the Final SEIS, as well as responding to the public comments on the Revised Draft SEIS, BOEMRE analysts examined the USGS report for new information relevant to understanding the potential environmental impacts of each lease sale alternative. Notwithstanding the title of the report, the USGS report in many cases identifies data "gaps" and recommendations which relate to issues beyond the scope of the BOEMRE mission and this lease sale decision.

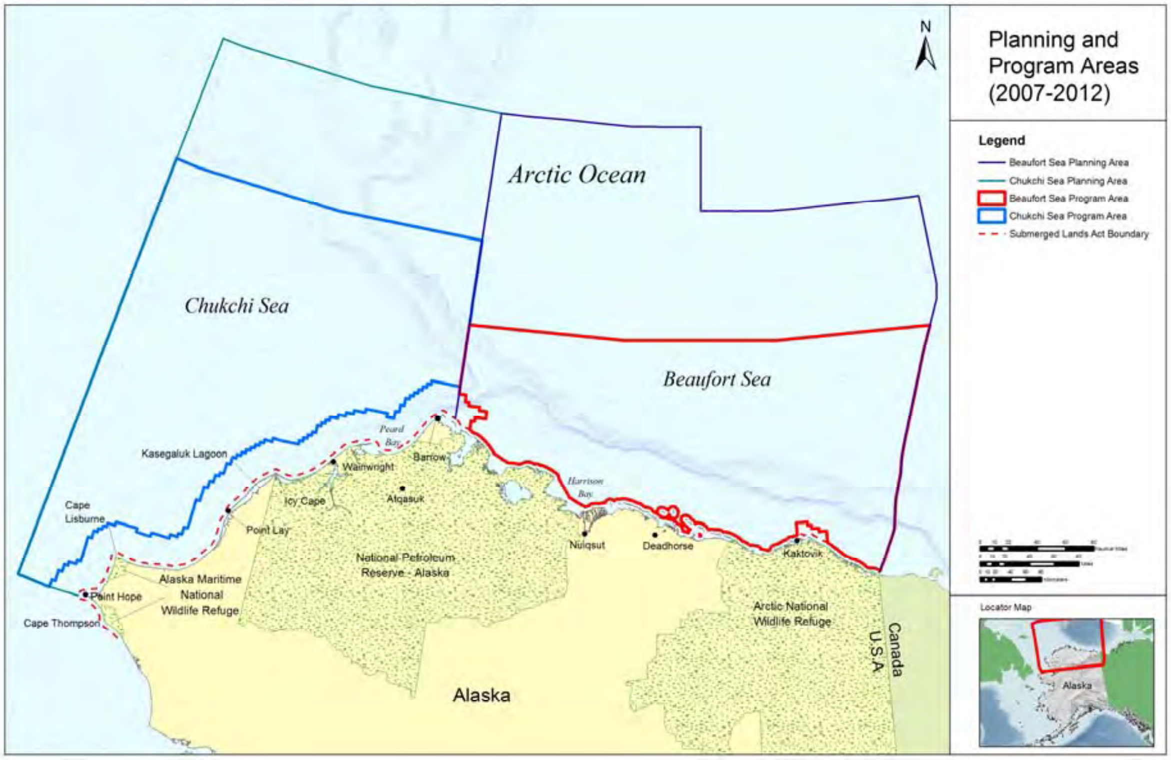

Figure 4. Chukchi and Beaufort Seas Planning Areas (larger green and purple borders) and 2007-2012 Program Areas (smaller blue and red borders). In March 2010, the Secretary removed further lease sales for the Chukchi and Beaufort seas program areas from the 2007–2012 Program.

I.G.4. Differences between the Revised Draft SEIS and the Final SEIS

The following summarizes some of the more important changes that have been made in the Final SEIS based on the public review of the Revised Draft SEIS:

- **Appendix E.** Appendix E has been added to the document. This appendix compiles the substantive comment letters received on the Draft SEIS and the Revised Draft SEIS, provides the transcripts from public hearings, and offers a thorough responses to public comments. BOEMRE received and reviewed approximately 150,000 comments on the Draft SEIS and approximately 360,000 comments on the Revised Draft SEIS. Apppendix E organizes substantive comments, by theme, into 36 Issue Categories. Within each Issue Category, substantive comments are summarized and then responded to. Substantive comments were identified as those pertaining to (1) BOEMRE's environmental effects analysis of the natural gas development and production scenario or the hypothetical Very Large Oil Spill (VLOS) scenario, or (2) BOEMRE's Analysis of Incomplete or Missing Information, conducted pursuant to 40 CFR 1502.22.
- **Text Revisions.** Text revisions have been made throughout the document to respond to public comments, to update the analysis, and for clarity. In many cases, text revisions constitute BOEMRE's response to public comments.
- **Revised Significance Thresholds.** In response to public comments, BOEMRE reevaluated its significance thresholds and determined that the thresholds for Subsistence-Harvest Patterns, Sociocultural Systems, Environmental Justice, Water Quality, and Air Quality should be modified or clarified. Revised thresholds are provided in Section IV.A.1 and described further in Appendix E.

- **Pictures and Quotations from Potentially Affected Communities.** In response to public comments, and to better inform readers about the Chukchi Sea region and the people who live there, the Final SEIS includes pictures depicting subsistence lifestyle and quotations of public testimony by community members.
- **More Figures and Tables.** In response to public comments, and to better communicate its analysis, BOEMRE provides additional figures and tables in various portions of the document.
- **The Preferred Alternative.** BOEMRE states a preferred agency alternative in Section II.B.1 of the Sale 193 Final SEIS.

Alternatives, Mitigation, and Issues

CHAPTER II. Alternatives, Mitigation, and Issues

II.A. Sale 193

The Secretary's Final OCS Leasing Program for 2007–2012 identifies certain areas of the Chukchi Sea Planning Area as suitable for lease for the development of offshore oil and gas resources. In February of 2008, BOEMRE held Chukchi Sea Lease Sale 193, and leased approximately 2.8 million acres in the Chukchi Sea Planning Area. In December 2010 the Secretary issued a Revised Program which superseded the original program decision made in 2007. Sale 193 remained in the Five-Year Program. Additional information on the 5-Year Program is in Section I.A.

II.B. Alternatives

After comprehensive scoping, a Draft EIS, and public and agency commenting processes, BOEMRE in June 2007 released the "Final Environmental Impact Statement for Oil and Gas Lease 193 and Seismic-Surveying Activities in the Chukchi Sea" (Sale 193 FEIS) (USDOI, MMS, 2007a). Because BOEMRE did not identify any additional alternatives for the scenarios discussed in this SEIS, the alternatives analyzed in the Sale 193 FEIS are carried forward for consideration here. Lease Sale 193 was held consistent with Alternative IV (as modified by the 25 statute mile coastal deferral area incorporated into the 2007-2012 Five-Year Program). Potential impacts under each alternative are nonetheless considered for consistency of this analysis with the analysis in the Sale 193 FEIS. The analysis did not disclose any additional impacts that would have warranted consideration of additional alternatives.

II.B.1. Alternatives Carried Forward in the Final SEIS

Alternative I (Proposed Action)

The Proposed Action offers for lease 6,156 whole or partial blocks within the Chukchi Sea. This area covers approximately 34 million acres. Specifically excluded from the Proposed Action is the 25 Statute Mile Buffer implemented by the Secretary in the Final OCS Leasing Program for 2007–2012. By selecting Alternative I, the Secretary would elect to offer for lease all 34 million acres of the Chukchi Sea made available by the Final OCS Leasing Program for 2007–2012. In as much as the sale has already been held and that sale only offered parcels identified in Alternative IV, full implementation of this Alternative is no longer feasible.

Alternative II (No Lease Sale)

This "no action" alternative is equivalent to not affirming Chukchi Sea Lease Sale 193. The opportunity to develop oil and gas resources that could have resulted from the Proposed Action would be precluded or postponed, as would any potential environmental impacts associated with the other alternatives. Its implementation would require the Secretary to cancel all leases awarded as a result of the February 2008 Lease Sale.

Alternative III (Corridor I Deferral)

This alternative is the Proposed Action minus a corridor 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. Alternative III would offer approximately 1,765 whole or partial blocks comprising 9.1 million acres (3.7 million hectares). The deferral of "Corridor I" would result in an estimated reduction of 36% of the oil and gas potential available for future production as compared with the entire Proposed Action (see Table IV.A-3 in the Sale 193 FEIS). Should the Secretary select Alternative III, portions of Chukchi Sale 193 could be affirmed, but leases issued on tracts within Corridor I would be cancelled (Figure 2).

Alternative IV (Corridor II Deferral) (Agency Preferred Alternative)

This alternative is the Proposed Action minus approximately 795 whole or partial blocks along the coastward edge of the sale area. The "Corridor II" deferral area is a subset of the Corridor I deferral area analyzed under Alternative III. The deferral of "Corridor II" results in an estimated reduction of 15% of the oil and gas resources for future commercial production as compared with the Proposed Action (see Table IV.A-3 in the Sale 193 FEIS). This alternative was identified as the Agency's Preferred Alternative in the Sale 193 FEIS, and was offered for lease as Sale 193 (February 2008) (Figure 2).

Alternative IV remains the agency preferred alternative in the Sale 193 Final SEIS. The agency's preferred alternative takes into account factors beyond the environmental effects analysis provided in this Final SEIS. The agency's preferred alernative is "the alternative which the bureau believes would best accomplish the purpose and need of the proposed action while fulfilling its statutory mission and responsibilities, giving consideration to economic, environmental, technical, and other factors" (43 CFR 4620(d)). Selection of Alternative IV would affirm the issuance of the leases pursuant to Lease Sale 193 as held and be implemented by removing the suspension of operations imposed on the leases.

II.B.2. Alternatives Considered But Not Analyzed

A full discussion of alternatives considered within the overall EIS process but not carried forward for detailed analysis is available in Section II.B.2 of the Sale 193 FEIS. BOEMRE has not identified any additional alternatives as a result of the addition of a natural gas development and production scenario in this Final SEIS, beyond those already considered in the Sale 193 FEIS.

II.C. Mitigation Measures and Issues Identified for Analysis

II.C.1. Mitigation Measures

Activities under each alternative would be subject to a variety of mitigation measures. More detailed discussion of applicable mitigation measures is available in Section II.B of the Sale 193 FEIS. BOEMRE has not identified any additional mitigation measures specific to the natural gas development and production evaluated in this Final SEIS. Most pertinent to the analysis of mitigation measures are the binding and enforceable measures known as lease stipulations, described below.

Lease Stipulations

This Final SEIS analyzes seven standard lease stipulations under each action alternative. Section II.B.3.c(1) of the Sale 193 FEIS provides the full text of these stipulations and an analysis of the expected effectiveness of each stipulation at mitigating adverse effects. All seven of the stipulations (listed below) were selected by the Secretary and incorporated into the leases resulting from Lease Sale 193 (February 2008).

- Protection of biological resources
- Orientation program
- Transportation of hydrocarbons
- Industry site-specific monitoring for marine mammal subsistence resources
- Conflict avoidance mechanisms to protect subsistence whaling and other subsistence-harvest activities
- Pre-booming requirements for fuel transfers
- Measures to minimize effects on spectacled and Steller's eiders from exploration drilling

II.C.2. Issues

The major issues framing the environmental analysis within this Final SEIS are those addressed in the District Court's remand of Sale 193 and evaluation of a hypothetical VLOS scenario. Issues related to OCS activities have been identified through many years of scoping for Alaska OCS lease sale evaluations, the 193 EIS process, and additional review conducted for this SEIS. A brief summary of identified issues related to the analysis of natural gas production and a VLOS is provided below. A comprehensive discussion of issues related to Sale 193 is available in Section II.B.5 of the Sale 193 FEIS.

Western Arctic Herd

There is 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.

Bowhead Whale

Commenters expressed concerns over the impacts that OCS activities may have on the bowhead whale and their migration patterns.

Marine Mammals

Commenters noted the potential for exploration and development activities to impact areas known to be critical to the subsistence harvest of marine mammals.

Water Quality Degradation

Issues related to water quality degradation included operational discharges, domestic wastes, sediment disturbance, and discharges from service vessels.

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.

OCS-Related Support Services, Activities, and Infrastructure

Concerns were expressed over activities related to support of OCS operations, including vessel and helicopter traffic and emissions.

Sociocultural and Socioeconomic

Concerns include employment impacts, cultural impacts, and population fluctuations.

Environmental Resources

Resources analyzed in the Sale 193 FEIS are carried forward for analysis within this Final SEIS. No additional resources were identified for the analysis of gas development and production. The following resources are analyzed in this Final SEIS:

- 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

BOEMRE also reviewed the comments received on the Sale 193 Draft EIS, as well as those on the Arctic Multi-Sale Draft EIS (USDOI, MMS, 2008a) to identify issues relevant to the analysis of natural gas production for the Chukchi Sea OCS. Through this process, BOEMRE identified two additional issues which are addressed in the Final SEIS: the potential for releasing hydrogen sulfide (H_2S) and related effects, and the potential effects of a gas release accident.

II.C.3. Issues Considered But Not Analyzed

The Sale 193 FEIS provides a discussion of issues considered but not carried forward for further analysis (Section II.B.5.b of the Sale 193 FEIS). All comments received in response to the Call for Information and Notice of Intent to Prepare an EIS, as well as those received during public scoping meetings, are part of the record of information used in developing the Sale 193 FEIS, and were summarized and made available to the decision-makers during the deliberation process. Several issues raised during scoping for the Sale 193 EIS were not considered for detailed study in the EIS, because they were out of the scope of the EIS and did not affect the environmental analyses. These issues include administrative, policy, or process issues, as seen below. No additional public scoping was conducted for this SEIS process.

BOEMRE has considered and “scoped out” the issues below from detailed analysis in this Final SEIS.

Tanker transport of produced natural gas (tankering of liquefied natural gas or LNG). The remand order by the U.S. District Court for the District of Alaska requires BOEMRE to analyze the environmental impact of natural gas development in the Chukchi Sea. To determine the appropriate gas devolvement and production scenario in this Final SEIS, BOEMRE Alaska OCS Region Office of Resource Evaluation evaluated three possible gas export strategies for the Chukchi Sea OCS based on current understanding of the geologic, engineering, economic, and political issues.

The first strategy consisted of transport via pipeline. Although different ways to transport gas from the North Slope have been discussed (ICF, Inc., 1982; Booz, Allen and Hamilton, 1983; GAO, 1983; Thomas et al., 1996; Sherwood and Craig, 2001), the most common conceptual plans involve a large-diameter, overland gas pipeline running south from the Prudhoe Bay area. Pipelines are the most cost-effective way to transport large volumes of oil or gas to market if overland routes are feasible. At present, work on several gas pipeline projects is progressing, but none of the projects have been approved or funded. Ongoing work by several competing gas pipeline projects increases the options for a gas project but also increases the uncertainties regarding timing of completion, route location, and capacity of the final project(s). Gas development in the Chukchi OCS would require a long (approximately 300 miles) overland pipeline across the NPR-A to connect to the new gas pipeline. The pipeline might be built in sections as gas development expands westward across NPR-A. Gas development in the Chukchi Sea OCS could reverse this situation, where a large gas field in the Chukchi supports a large overland gas pipeline to Prudhoe Bay. This way, the remote gas resources from the Chukchi could promote the development of marginal gas pools stranded in NPR-A. In either case, gas development in NPR-A and the Chukchi Sea would be important to a future North Slope gas pipeline where the huge investment (>$ 30 billion) is based on a long-term (> 25 year) project.

LNG is a second possible means to export gas from the Chukchi Sea OCS, but is a less likely alternative. LNG operations will face difficult economic, technical, and regulatory challenges because they are a new concept to the region. LNG operations require expensive infrastructure, including pipelines, a large processing facility, a marine loading terminal, a fleet of LNG tankers, and receiving terminals at market destinations. Numerous feasibility and environmental issues will be present for each of these components in the LNG delivery chain. Marine transportation in the Arctic is restricted by sea-ice conditions that could inhibit tanker loadings and transits for 6 months of the year. No LNG ships have been built to handle severe ice conditions common in the Chukchi. Nearshore areas are relatively shallow and water depth could limit the size of LNG ships (loaded draft of 40 ft [12 m]).

A third strategy for gas development involves offshore processing, storage and loading to marine tankers for export. Bottom-founded production platforms in the Chukchi Sea would be very large to resist ice forces in waters greater than 100 ft. Because of their large size, platforms could be designed with internal storage compartments to hold oil or gas. Offshore loading and tanker traffic would be affected by rough seas in the open-water season (July-November) and severe sea ice conditions during the rest of the year. This strategy would face numerous economic, engineering, and regulatory challenges.

Overall, this analysis suggests that a pipeline export system is the most likely scenario for transportation of natural gas development in the OCS areas off northern Alaska. Should other transportation methods be determined reasonably foreseeable in the future, the staged OCS process and parallel NEPA compliance would require full consideration of the consequences of such transportation at the time of a decision that could foreseeably result in use of that method of transport. Accordingly, tanker transport of produced natural gas is not analyzed in this Final SEIS.

The community of Wainwright wants natural gas produced from the Chukchi Sea OCS to be made available to the community for power generation. This issue is beyond the scope of the current analysis. A contract between two parties (the gas producer and Wainwright) cannot be required or enforced by the Federal Government.

Greenhouse gas emissions from consumption of produced natural gas. Environmental and economic impacts of greenhouse gas emissions from oil and gas consumption are not effects of Sale 193 as defined by the Council on Environmental Quality, and thus are not required to be analyzed under NEPA. Greenhouse gas emissions from consumption of Sale 193 oil and gas are not direct effects under NEPA because they do not occur at the same time and place as the action. They are also not indirect effects because Sale 193 would not be a proximate cause of greenhouse gas emissions resulting from consumption. Also, because the impacts of consumption are not direct or indirect effects of the proposed action, a cumulative impact analysis would not reveal an incremental or cumulative effect attributable to the decision to affirm, modify, or cancel the lease sale.

There is no reliable methodology to assess the relation between leasing in the Chukchi Sea and changes in nationwide or worldwide oil and gas consumption levels. Consumption of oil and gas is driven by a variety of complex interacting factors including energy costs, energy efficiency, availability of other energy sources, economics, demography, and weather or climate. While on a national basis, lower levels of domestic oil and gas production could occur and may trigger some modest conservation measures having some benefits in terms of reduced greenhouse gas emissions, no single leasing decision would be expected to result in any discernable responsive conservation measures. This is particularly true with regard to Sale 193 where the actual productive capacity is currently an unknown. Furthermore, it is not known whether or to what extent Sale 193 oil and gas would be refined into plastics or other products that will not be burned, what mix of vehicles or power plants might utilize the product, or what mitigation measures would offset any such consumption.

Moreover, BOEMRE does not regulate fuel consumption or carbon emissions at any level, nor does BOEMRE dictate the destination of the oil and gas produced from a federal lease or the products to be refined from it, which would determine the emissions produced. While the Energy Information Administration has reported emissions from a variety of petroleum products (e.g., aviation gasoline, motor gasoline, etc.), natural gas and other gaseous fuels (e.g., methane, landfill gas, etc.), electricity, coal, and renewable sources, an attempt to translate this information into emissions from the ultimate consumption of the oil and gas produced under Sale 193 would be an unreasonably speculative exercise.

II.D. Summary of Environmental Impacts

This section briefly summarizes the detailed impact analyses of both the Sale 193 FEIS and this Final SEIS. Conclusions from each document are presented by alternative, and for each resource area potentially affected under that alternative. For each resource subsection, the potential impacts associated with oil exploration, and development and production (including potential effects from a large accidental oil spill) are discussed first. This information is summarized from the Sale 193 FEIS.

Each resource subsection also includes a summary of the potential impacts of natural gas development. These conclusions are derived from Chapters IV and V of this Final SEIS. As will be explained in more detail within Chapter IV, the impact analysis herein is predicated on the most viable natural gas development and production scenario that could result from Sale 193. This scenario assumes that any natural gas development and production would utilize an existing (due to oil development and production) platform located near the center of the Sale 193 area. This is the same platform location as was assumed and analyzed in the Sale 193 FEIS. The gas development and production scenario would also utilize the existing shorebase, and run new offshore and onshore gas pipelines along the same corridor as the existing oil pipelines. A more detailed explanation of how BOEMRE developed this natural gas development and production scenario is provided in Section IV.B. Since this scenario entails similar infrastructure (including the production platform, wells, both offshore pipelines, shore base, and both onshore pipelines) and activities for each action alternative, potential impacts are also similar under each action alternative. Due to these similarities, and for the sake of brevity, discussion of the potential impacts under each action alternative are often grouped together.

However, the potential natural gas development and production impacts under each action alternative analyzed are not necessarily identical. Alternatives III and IV each include deferral areas that would exclude from the lease sale notable portions of the coastward edge of the Chukchi Sea Planning Area. If the decision-maker were to select Alternative III or IV, no wells or platforms could be constructed within the applicable deferral area. Deferring certain areas from consideration could in this sense affect the type and severity of potential environmental impacts. Coastal areas can be particularly sensitive to potential impacts to marine mammals, marine and coastal birds, subsistence, and other valued environmental resources. Increasing the minimum distance between certain potential development and production activities and the Chukchi Sea coastline could potentially benefit several resources in a general way. As was the case with the oil scenario analyzed in the Sale 193 FEIS, any differences in the potential environmental impacts associated with gas development and production under each action alternative analyzed are directly traceable to the size and location of proposed deferrals.

Finally, each resource subsection includes a summary of the potential impacts of a VLOS scenario. These discussions follow much the same approach for natural gas development and production, explained above.

Significance thresholds are defined in Section IV.A.1. References are provided in the sections being summarized. For Oil Exploration, Development, and Production, see Chapter IV and V of the Sale 193 FEIS. For Natural Gas Development and Production, see Sections IV.C and V.B of the Final SEIS. For VLOS, see section IV.E of the Final SEIS.

II.D.1. Summary of Impacts: Alternative I – Proposed Action

Water Quality

Oil Exploration, Development, and Production

The effect of the Proposed Action on water quality as a result of exploration, development, and production is expected to be moderate locally and low regionally. Discharges into the marine environment would be regulated by EPA through NPDES permitting and inspection requirements. The risk of an accidental large oil spill would be reduced by mitigation measures (see Sale 193 FEIS, p. IV-38).). If a large oil spill (analyzed in the Sale 193 FEIS as 1,500 bbl of oil for a platform spill, or 4,600 bbls of oil for a pipeline spill) were to occur, water quality would be affected at both the regional and local scales at low to moderate levels. For additional information, see Section IV.C.1.a of the Sale 193 FEIS (USDOI, MMS, 2007a).

The Final SEIS incorporates revisions to the significance threshold for water quality. These changes do not affect the conclusions of the Sale 193 FEIS.

Natural Gas Development and Production

Natural gas development and production is not expected to cause significant effects on water quality. Temporary and localized adverse effects are likely to result from installation of a new offshore natural gas pipeline, infrequent deck drainage discharges and effects on stream water quality at pipeline or support road crossings. The effect of these activities on regional water quality would remain low.

VLOS

In the event of a VLOS (a spill of more than 150,000 barrels of oil), sustained degradation of water quality would occur through hydrocarbon (oil and natural gas) contamination. State and Federal criteria would be exceeded, causing significant impacts. Impacts from the oil spill itself could be exacerbated during spill response and cleanup activities such as vessel discharge, in-situ burning, dispersants, drilling a relief well, and shoreline cleanup.

Air Quality

Oil Exploration, Development, and Production

Proposed actions would comply with Federal and State of Alaska air quality and emissions requirements. As a result, the effect of the Proposed Action on air quality is expected to be low, and air quality is expected to remain well within National Ambient Air Quality Standards and Prevention of Significant Deterioration incremental limits. For additional information, see Section IV.C.1.b of the Sale 193 FEIS (USDOI, MMS, 2007a).

The Final SEIS incorporates revisions to the significance threshold for air quality. These changes do not affect the conclusions of the Sale 193 FEIS.

Natural Gas Development and Production

Minor adverse impacts to air quality would occur from the emissions of reciprocating diesel engines, gas turbines, and generators generally associated with development and production activities. However, any increase in concentrations of criteria pollutants from these activities would be small and localized. Overall effects would be low and would not exceed any Clean Air Act standards.

Natural gas development and production would result in a negligible contribution to U.S. and global greenhouse gas emissions.

VLOS

In the event of a VLOS, large amounts of regulated, harmful pollutants could be emitted into the atmosphere. An initial explosion of gas and oil would result in a large plume of smoke containing several types of pollutants. Significant impacts to air quality could occur from the evaporative emissions of a large quantity of offshore oil. Certain spill response and cleanup activities such as in-situ burning would also cause adverse impacts. The duration of these impacts depends on regional weather and the size and duration of the spill.

Lower Trophic Level Organisms

Oil Exploration, Development, and Production

The level of effect on lower trophic level organisms with standard mitigation would be minor, with moderate impacts near drilling locations and from trenching for pipeline installation. A large oil spill contacting the coast could persist in tidal and sub-tidal sediments for tens of years with moderate effects on local lower trophic communities. For additional information, see Section IV.C.1.c of the Sale 193 FEIS (USDOI, MMS, 2007a).

Natural Gas Development and Production

Several components of the natural gas development scenario, such as installing an offshore gas pipeline and anchoring vessels, have the potential to impact lower trophic level organisms. However, these impacts would be localized and temporary, given the expectation of eventual recolonization. No adverse impacts to lower trophic level organisms are expected to result from natural gas production. Overall, no significant adverse effects on this resource would occur.

VLOS

In the event of a VLOS, negative direct and indirect effects would occur with respect to many lower trophic level organisms and their communities. Recovery time is dependent upon the duration and timing of the spill, life cycle developmental stages, and physical factors (i.e. weather and currents) influencing the movement of oil and organisms through the described environment. Effects are generally anticipated to be less than one year for phytoplankton populations and one or more years for invertebrate populations within the pelagic, benthic, epontic, and onshore communities. Negative effects on local foodwebs would result.

Fish Resources

Oil Exploration, Development, and Production

Construction activities are anticipated to result in temporary and localized effects on fish and fish habitats, with recovery expected to occur in fewer than three generations. A large oil spill contacting intertidal or estuarine habitats used by fishes could result in significant impacts to some local breeding populations. Recovery to former status, likely by immigration, would require more than three generations. For additional information, see section IV.C.1.d of the Sale 193 FEIS (USDOI, MMS, 2007a).

Natural Gas Development and Production

Several types of direct and indirect impacts would occur as a result of the natural gas development and production scenario. Mitigation measures would reduce the direct and indirect effects on fish. Noise would affect fish species in various ways, particularly those species and life-stages that are weak or non-swimmers (eggs, larvae) or benthic obligates. Impacts would occur to seafloor habitat from pipeline installation and anchoring, and to freshwater and riparian habitat from onshore pipeline installation. Some of these effects on fish cannot be avoided; however, overall effects would be minor.

VLOS

In the event of a VLOS, large quantities of oil (offshore and nearshore) and natural gas (offshore) could cause significant impacts to several species of fish. The effects on fish and their populations would depend on a variety of factors including life stage, season of the reproductive cycle, species' distribution and abundance, locations of the species in the water column or benthos, the extent and location of spawning areas in riverine systems, and migratory patterns. Particularly vulnerable are various life stages of the following species: pink and chum salmon, Arctic cod, sand lance, capelin, nearshore sculpin species, nearshore flounders and plaice, saffron cod, migratory least cisco, migratory dolly varden, migratory Arctic char, rainbow smelt, stickleback, and migratory whitefish.

Essential Fish Habitat

Oil Exploration, Development, and Production

Seismic surveys conducted in association with the proposed lease sale would have minor impacts on Essential Fish Habitat (EFH). Construction-related disturbance is also expected to result in minor impacts to freshwater and marine salmon EFH, Arctic cod EFH, and saffron cod EFH. A large oil spill or chronic small oil spills could impact the EFH of Arctic cod and saffron cod. A large oil spill or chronic small-volume oil spills impacting intertidal or estuarine habitats used by early life-history stages of Pacific salmon would be likely to result in significant effects on local populations. Large or chronic small-volume spills would require three or more generations to recover to their former status. For additional information, see Section IV.C.1.e of the Sale 193 FEIS (USDOI, MMS, 2007a).

Natural Gas Development and Production

Construction of an onshore gas pipeline would cause minor impacts to salmon freshwater EFH. In the event of a large-scale natural gas release, the chemical and physical water column environment of Arctic cod, Pacific salmon and, in areas, saffron cod Essential Fish Habitat would be affected at a negligible to minor level.

VLOS

Essential Fish Habitat for Arctic cod, saffron cod, and all five species of Pacific salmon would be significantly impacted in the event of a VLOS.

Threatened and Endangered Marine Mammals

In addition to the species discussed in this section, several marine mammals have been recently proposed for listing under the ESA, a group that includes Pacific walrus, bearded seal, and ringed seal. The potential impacts of the Proposed Action on these species are discussed within the Other Marine Mammals section (below). For additional information, see Section IV.C.1.f(2) of the Sale 193 FEIS (USDOI, MMS, 2007a).

Oil Exploration, Development, and Production

Overall, bowhead whales and polar bears exposed to noise-producing activities such as vessel and aircraft traffic, drilling operations, seismic surveys, and construction activities would be likely to experience temporary, non-lethal effects. It is unlikely that fin and humpback whales would be adversely affected by noise-causing oil and gas activities in the Proposed Action area. Prolonged exposure to freshly spilled oil could cause whale mortalities, but, based on available information, the number would be small if the spill contacted bowheads in open water. If a large amount of fresh oil contacted a significant portion of a large aggregation of bowheads, especially with a high percentage of calves, effects could be greater than under more typical circumstances, potentially rising to a population-level adverse effect. Significant impacts to polar bears could occur during a large oil spill, depending on the location of the spill. For additional information, see Section IV.C.1.f(1) of the Sale 193 FEIS (USDOI, MMS, 2007a).

Natural Gas Development and Production

Potential impacts to listed whales from natural gas development and production would be similar to those from oil development and production, as described in the paragraph above. No additional exploration or drilling activities would take place during the natural gas scenario, and the potential for a large oil spill would no longer exist. Natural gas development and production could result in increased noise and disturbance to bowhead as well as fin and humpback whales. Bowhead, fin and humpback whales exposed to noise-producing activities such as vessel and aircraft traffic, construction activities, and production activities most likely would experience temporary, non-lethal effects. There is variability in whale response to certain noise sources; this variability appears to be context specific (e.g., feeding versus migrating whales) and also may be related to reproductive status and/or sex or age. Overall impacts are expected to be minor.

Various aspects of the natural gas development and production scenario have the potential to disturb polar bears, but most impacts would be temporary and non-lethal, and would not rise to the level of significance. Additional ESA Section 7 consultation would be required before BOEMRE approves any development and production plan that could follow from a lease sale. The current regulatory framework provides for an authorization to incidentally take ESA-listed marine mammals by harassment, provided the taking is also authorized under the Marine Mammal Protection Act (Section 101(a)(5)(A–D) of the Marine Mammal Protection Act of 1972 (MMPA) as amended (16 USC 1371(a)(5)). That process would identify and require any additional, site-specific mitigation deemed necessary by FWS to further avoid impacts to polar bears or to avoid adverse modification of critical habitat.

VLOS

In the event of a VLOS, significant effects on endangered cetacean species (including bowhead, fin, and humpback whales) and polar bears could occur through several mechanisms, specifically inhalation of toxic fumes from freshly spilled oil, loss of seasonal habitat, reduction in prey, and contamination of prey. Spill response and cleanup activities can also displace each species from important habitat areas. Contact with oil would result in lethal effects for polar bears. Contact with oil could also result in lethal effects on cetaceans under certain circumstances. High levels of ingestion or exposure to toxic fumes could lead to death of individuals. Spill response and cleanup efforts can lead to additional exposure as well as disturbance and displacement of polar bears.

Other Marine Mammals

Other marine mammals found in the Chukchi Sea include gray whale, minke whale, beluga whale, killer whale, harbor porpoise, Pacific walrus and ice seals.

Oil Exploration, Development, and Production

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, decreased reproductive success, and changes in prey resources. Significant impacts could occur to belugas and/or walrus through the loss of large numbers of individuals in the event of a large oil spill. For additional information, see Section IV.C.1.h of the Sale 193 FEIS (USDOI, MMS, 2007a).

Natural Gas Development and Production

While the complexity of how marine mammal species react to underwater and above water sound renders an exact determination of potential adverse impacts difficult, abundant regulatory review and careful design of project-specific and activitiy-specific mitigation measures are expected to preclude instances of level A ("harm") take of marine mammals and to reduce the potential for level B ("harassment") take as regulated under the MMPA. No population-level impacts are anticipated to result from natural gas development and/or production.

VLOS

Non-listed cetaceans (including gray, minke whales, beluga whales, killer whales, and harbor porpoise) could experience significant impacts in the same manner as the listed cetaceans discussed above. Those cetaceans with a greater tendency towards seasonal aggregation, namely the beluga whale, would be at higher risk of population-level impacts. Gray whales could be particularly affected if benthic invertebrate prey are lost or contaminated. The greatest potential for significant impacts to pinnipeds (including bearded, ringed, ribbon, spotted seals and walrus) in the Chukchi Sea is from long-term exposure to contaminants as well as from decreased availability of prey species (fish and invertebrates). If hydrocarbons from a VLOS become sequestered in marine sediments, then the walrus diet of benthic organisms makes it particularly vulnerable to long-term chronic ingestion of hydrocarbons as well as reductions in prey availability in important habitat areas or near haulout locations. Walrus are also sensitive to disturbance when congregated on ice or at coastal haulouts.

Threatened and Endangered Marine and Coastal Birds

The yellow-billed loon was recently classified as a candidate species. The potential impacts of the Proposed Action on this species are considered within the Other Marine and Coastal Birds section, below.

Oil Exploration, Development, and Production

Disturbance, collision hazards, and oil/toxic pollution 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, disturbance and oil/toxic pollution 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. OCS activities in the Ledyard Bay Critical Habitat Unit (LBCHU) could result in physical modification of seafloor habitats and decreased use of the LBCHU by molting spectacled eiders. Without comprehensive mitigation measures to avoid or minimize potential impacts, physical modification of the LBCHU seafloor would adversely modify the LBCHU. For additional information, see Section IV.C.1.f(2) of the Sale 193 FEIS (USDOI, MMS, 2007a).

Natural Gas Development and Production

The natural gas development and production scenario analyzed in this SEIS comprises activities that are very similar or even identical to those analyzed in the preceding Sale 193 FEIS, and does not include some of the higher-risk activities (i.e. seismic surveying and exploration, platform construction, and oil production). In this sense, one can expect natural gas-related impacts to be a continuation of the potential adverse environmental impacts associated with the oil development and production activities analyzed in the Sale 193 FEIS. The Sale 193 FEIS as well as each Biological Opinion found notable potential for adverse impacts to Threatened and Endangered marine and coastal birds, but also explained that many of these potential impacts could be avoided or mitigated. It is reasonable to presume that through development of additional, site-specific mitigation measures during later environmental review processes, the new activities associated with the gas scenario (namely installing and operating an offshore gas pipeline, expanding an onshore facility, and installing and operating an onshore gas pipeline though NPR-A) would produce only minor impacts on Threatened and Endangered marine and coastal birds. No significant impacts are expected from any potential releases of natural gas. Significant adverse effects could occur from extending the life of the platform and other facilities, should high numbers of Threatened or Endangered birds from declining populations suffer mortality from collisions. Additional discussion on the types of impacts that could affect marine and coastal birds generally is provided in the section below.

VLOS

In the event of a VLOS, significant impacts could occur to Steller's and spectacled eiders if spilled oil reaches LBCHU. Kittlitz's murrelts could experience significant impacts if oil contacted a large enough portion of Alaska's Chukchi Sea coast.

Other Marine and Coastal Birds

Oil Exploration, Development, and Production

Marine and coastal birds could be adversely affected by OCS activities through disturbances, collisions, habitat loss, petroleum exposure, and exposure to toxic contamination. Several areas in the Chukchi OCS are historically documented to be important to marine and coastal birds, and 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 also high. Spilled oil has the greatest potential for affecting large numbers of birds. Most notably, a large spill could impact common and thick-billed murres in late summer and early fall, when 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 lead to a sharp decrease in murre abundance at the Cape Thompson and Cape Lisburne colonies. For additional information, see Section IV.C.1.g of the Sale 193 FEIS (USDOI, MMS, 2007a).

Natural Gas Development and Production

As marine and coastal bird presence is quite variable by season and location, an accurate assessment of impacts at this early stage is difficult. Additional NEPA and other environmental review processes occurring at later stages of the OCS Lands Act program (i.e. exploration, development and production) will have site-specific plans to focus an analysis. Significant adverse impacts to marine and coastal birds would be avoided and mitigated through restriction and measures implemented during those later review processes.

VLOS

If marine and coastal birds came into contact with oil from a VLOS, they could experience exposure from wetting and loss of thermoregulatory ability, loss of buoyancy, or from matted plumage, inability to fly or forage, ingestion of oil, and inhalation of vapors. The greatest potential for significant impacts is if spilled oil reached important habitat areas. Non-listed marine and coastal birds that are particularly vulnerable to population-level impacts are murres, puffins, short-tailed shearwaters and auklets, black guillemot, long-tailed ducks, common eider, king eider, black-legged kittiwake, Pacific brant, phalaropes, lesser snow geese, and other waterfowl and shorebirds.

Terrestrial Mammals

Oil Exploration, Development, and Production

Among the terrestrial-mammal populations that could be affected by oil exploration and development in the Sale 193 area are caribou (Central Arctic, Western Arctic, and Teshekpuk Lake herds), muskoxen, grizzly bears, and Arctic foxes. The primary potential effects of OCS exploration and development activities on terrestrial mammals would come from disturbance associated with ice-road and air-support traffic along pipeline corridors and near other onshore-support facilities. Habitat alteration associated with gravel extraction (mining) to support the construction of gravel pads for onshore facilities is possible. Effects could also come from potential oil spills contacting coastal areas used by caribou for insect relief, and for 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 (Joly et al., 2006; Cameron et al., 2005; Haskell et al., 2006). 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. For additional information, see Section IV.C.1.i of the Sale 193 FEIS (USDOI, MMS, 2007a).

Natural Gas Development and Production

It is likely that several species of terrestrial mammals would be temporarily disturbed by natural gas development, and to a lesser extent, natural gas production activities. Negative impacts of this type can be difficult to quantify. However, existing data and anecdotal evidence strongly suggest that no species of terrestrial mammal would suffer significant adverse impacts.

VLOS

With the exception of caribou, terrestrial mammals do not aggregate in coastal areas in numbers sufficient to permit population level effects from oiling. Even if a large group of caribou happened to be directly affected, it is most likely that full recovery of population numbers would occur within two years. Terrestrial mammals such as bears, wolves, wolverines, and fox could also be affected through consumption of contaminated prey or carcasses, but effects are not anticipated to be significant.

Vegetation and Wetlands

Oil Exploration, Development, and Production

Seismic surveys and exploration activities would be concentrated offshore, with no impacts on onshore and inland vegetation and wetlands. Impacts on wetlands and terrestrial vegetation communities resulting from oil development and production would likely be localized. There would be negligible impacts on the ecological functions, species abundance, and composition of wetlands and plant communities of the North Slope at a regional scale. There would be a risk for major impacts in the event of a large oil spill. For additional information, see Section IV.C.1.j of the Sale 193 FEIS (USDOI, MMS, 2007a).

Natural Gas Development and Production

Given the unique sensitivity of the tundra ecosystem in the region analyzed, potential impacts to vegetation associated with natural gas development and production may be long lasting (e.g. disruption of slow-recovering vegetation communities) or even permanent (e.g. thermokarst). These impacts would,likely be localized rather than regional, and limited to the activities resulting from pipeline construction.

VLOS

If oil were to contact vegetation and wetlands resources, it could persist for 10 years or more. However, very little of the Arctic shoreline includes habitats that are especially sensitive to oil impacts. Tundra and marsh areas would only be affected if the presence of spilled oil coincided with a storm surge event, or by certain cleanup activities.

Economy

Oil Exploration, Development, and Production

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 approximately 15% in the latter years. In the early years of production, each sale would generate increases in revenues to the State of Alaska of about <0.3%. The increases would taper off to an even smaller percentage in the latter years of production. The change in total employment and personal income would be approximately 6% over the 2003 baseline for the NSB and 2% 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. Sale193 would contribute to extending the lifespan of the Trans-Alaska Pipeline System (TAPS). For additional information, see Section IV.C.1.k of the Sale 193 FEIS (USDOI, MMS, 2007a).

Natural Gas Development and Production

Natural gas development and production under the Proposed Action would result in a variety of beneficial economic impacts, namely employment, personal income, and revenues.

VLOS

A VLOS would generate several thousand direct, indirect, and induced jobs, and millions of dollars in personal income associated with oil spill response and cleanup in the short run. A VLOS could also have negative long-term impacts to potential activities in the future.

Subsistence-Harvest Patterns

Oil Exploration, Development, and Production

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 might occur over the life of the field, the communities that use this area heavily for their subsistence resources would be those most affected by oil exploration, development, and production 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 could periodically 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 having a very low effect to having a low effect in the local context, and would be of short-term duration and have no regional population effects. No resource or harvest area would become unavailable or undesirable for use, and no species would experience overall population reductions. In the case of a large oil spill, 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. For additional information, see Section IC.C.1.l of the Sale 193 FEIS (USDOI, MMS, 2007a).

The Final SEIS incorporates revisions to the significance threshold for subsistence-harvest patterns. Applying the updated threshold, construction activity could disrupt subsistence activities in Wainwright and communities closest to development (USDOI, MMS, 2007a, p. IV-195). These impacts would be significant, and could continue through the life of the development if subsistence users are displaced from areas near development (USDOI, MMS, 2007a: IV-190-91, 195).

Natural Gas Development and Production

While natural gas development and production is not expected to appreciably reduce any populations of subsistence species, it is possible that disturbance caused by these activities could alter the local availability of these resources to harvesters for substantial portions of one or more subsistence seasons.

VLOS

A VLOS in the Chukchi Sea could significantly affect subsistence-harvest patterns in several ways. Subsistence resources could be diminished, displaced and more difficult to access, and/or contaminated. Concerns about contamination could persist many years, long after actual harvest disruption. In light of sharing networks, a spill originating in the Chukchi Sea region could produce indirect impacts felt by communities remote from the sale area and far removed from the spill.

Sociocultural Systems

Oil Exploration, Development, and Production

The effects of the 3D/2D seismic activities that are projected to occur are likely to be minimal. Effects on social well-being (social systems) would 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 five 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, most likely from the placement of onshore infrastructure (that is, the shore base in the scenario). The most prominent effect would be the change in land use from the introduction of industrialization. Wainwright could experience effects on social organization, cultural values, and institutional organization for a period exceeding five years. Displacement of social patterns could occur as a result of social system adaptation to chronic disruptions. In addition, social patterns could be affected by a growing cash economy sector from offshore exploration support activities as it impacts existing subsistence practices in Chukchi Sea coastal villages.

For a large oil spill, noticeable disruption could occur from the oil spill and cleanup 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. 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. For additional information, see Section IV.C.1.m of the Sale 193 FEIS (USDOI, MMS, 2007a).

The Final SEIS incorporates revisions to the significance threshold for sociocultural systems. Applying the updated threshold, disruptions of social organization, cultural values, and/or instutional arrangements could exhibit a tendency to displace existing social patterns in Wainwright. Such significant impacts would be limited to communities (like Wainwright) in close proximity to development.

Natural Gas Development and Production

The following conclusions may be drawn from the analyses:

- At the regional level (NSB), effects from Sale 193 natural gas development and production should not exceed the significance threshold.
- At the local level (Wainwright in the scenario), effects from Sale 193 natural gas development and production could exceed the significance threshold, though potential displacement of present-day social patterns may have already occurred from the oil development scenario.
- Mitigation measures should prove effective in ameliorating many of the effects of Sale 193 natural gas development and production. Social systems are expected to successfully respond and adapt to the change brought about by the continuation of production activities. This accommodation response represents circumstances that could reduce the likelihood of significant impacts.

VLOS

A VLOS could disrupt sociocultural systems, with a tendency to displace existing social patterns. Longer term disruptions to subsistence resources and practices would compound these effects.

Archaeological Resources

Oil Exploration, Development, and Production

Archaeological surveys and analyses are required in areas where potential archaeological resources are at risk from offshore operations. These requirements are specified in the 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 resource, either onshore or offshore, is expected to be identified through examination of cores, where applicable, and/or through required site-specific surveys before any activities are permitted. Potential effects will be avoided or mitigated in this manner. For additional information, see Section IV.C.1.n of the Sale 193 FEIS (USDOI, MMS, 2007a).

Natural Gas Development and Production

There is a small potential that certain natural gas development activities could cause irreversible adverse impacts to currently unknown archaeological resources. Such impacts could be significant. However, the potential for significant adverse impacts will be further reduced through adherence with standard pipeline construction protocols and measures identified during the NHPA Section 106 consultation process.

VLOS

An irreversible adverse impact to an archaeological resource is significant. The aspect of a VLOS scenario with the highest potential to cause such impacts is onshore spill response and cleanup activities that can alter site dynamics and increase resource degradation, resulting in potential adverse effects on historic properties.

Environmental Justice

Oil Exploration, Development, and Production

Alaskan Iñupiat Natives are the predominant residents of the North Slope communities. As such, they could be disproportionately affected by disturbance impacts from seismic activity, vessel, aircraft, 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. Potentially significant impacts to subsistence resources and harvests, and consequent impacts to sociocultural systems, could result in adverse Environmental Justice impacts. With required mitigation and conflict avoidance measures in place, significant impacts to subsistence resources and hunts from seismic activity, noise, and disturbance would not be expected to occur. As a result, significant impacts on sociocultural systems and disproportionately high adverse impacts on low-income and minority populations in the region would be avoided. Disproportionately high and adverse impacts to this group could occur in the unlikely event of a large oil spill, however. For additional information, see Section IV.C.1.p of the Sale 193 FEIS (USDOI, MMS, 2007a).

The Final SEIS incorporates revisions to the significance threshold for Environmental Justice. Applying the updated threshold, significant impacts to the subsistence harvest patterns and sociocultural systems of Wainwright caused by the construction and operation of the on-shore facilities would lead to significant impacts for Environmental Justice. No other disproportionate, high adverse impacts are expected.

Natural Gas Development and Production

Significant impacts may occur to subsistence harvest patterns for those Alaska Iñupiat Natives, the only significant minority group within the action area, who live in close proximity to development areas. This may lead to a significant impact to Environmental Justice.

VLOS

A VLOS in the Chukchi Sea would cause disproportionate high adverse environmental and health impacts to defined minority populations in the Chukchi Sea Region, specifically Alaska Inupiat Natives.

II.D.2. Summary of Impacts: Alternative II – No Lease Sale

Under the No Action alternative (Alternative II), the Secretary would decline to affirm Sale 193, and would instead cancel the leases. Selection of this alternative would effectively eliminate the possibility for offshore oil and gas development and production as a result of Sale 193, although such activities could occur within the Chukchi Sea under a future lease sale. Potential environmental impacts to the marine, coastal, and human environment from offshore development and production would not occur or would be delayed. Economic benefits to local communities (income for business and individuals), the North Slope Borough (property tax for onshore infrastructure), the State of Alaska (corporate income taxes), and the Federal Government (tract rental fees, taxes, royalties on production) would not be realized at this time due to delay and/or missed opportunities. The selection of this alternative would also postpone potential contributions to national energy supplies delivered through the Trans Alaska Pipeline System (TAPS). This key pipeline system provides energy security to the U.S. and great economic benefits to the State of Alaska. A variety of adverse and beneficial impacts generally associated with petroleum production could be displaced to other localities, both domestic and foreign.

II.D.3. Summary of Impacts: Alternative III – Corridor I Deferral

The major difference between Alternative III (Corridor I deferral) and Alternative I (the Proposed Action) is that the blocks within the deferral area would not be offered for lease under Alternative III. Exploration seismic surveying, ancillary activities along potential pipeline routes, and installation of a pipeline to shore could still occur within the deferral corridor. No exploration or development drilling or platform construction would occur within the deferred area.

This deferral corridor would increase the minimum distance from shore in terms of the following:

- Length of gas pipelines from a platform to shore
- Travel distances for vessels and aircraft supporting exploration and development drilling activities and platform construction and operations
- Discharges, emissions, and noise associated with drilling and platform installation and operation
- The source of a VLOS

The deferral area (Corridor I) under Alternative III is wider (i.e., defers more blocks) than the deferral area (Corridor II) under Alternative IV. The minimum distance from shore for activities listed above is longer under Alternative III as compared with Alternative IV.

Summaries of potential impacts under Alternative III are presented first for the oil exploration, development, and production scenario analyzed in the Sale 193 FEIS (USDOI, MMS, 2007a), then for the natural gas development and production scenario analyzed in Sections IV.B and IV.C, and lastly for the VLOS scenario analyzed in Sections IV.D and IV.E.

Oil Exploration, Development, and Production

Water Quality

The level of potential activities remains the same for Alternative I, III, or IV; therefore, the actions and sources of water quality degradation do not change. The deferral areas may avoid localized discharges to marine waters; however, the removal of the deferred lease blocks would not significantly change the effects on marine water quality either negatively or beneficially. Permitted discharges that are compliant with granted permits would not pose a significant degree of risk to water quality at the various proposed development and production sites.

Air Quality

Potential air quality impacts to adjacent onshore areas would be lower under Alternative III than Alternative I because of the greater distance from shore of the nearest tract available for leasing. The difference in potential impacts, however, is small.

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. The deferral of 1,765 whole or partial blocks near the coast would decrease the level of potential effects. Therefore, total effects from Alternative III would be lower than total effects summarized for Alternative I (above), but the relative level of effects from each alternative would be similar.

Fish Resources

The primary benefit of Alternative III is that it would move sources of potential effects farther away from important coastal and anadromous fish habitats. The increased distance between offshore development and coastal fish habitats could also conceivably decrease the chance of spilled oil contacting the coastline, increase the weathering of spilled oil prior to contact, and increase the available spill response time.

Essential Fish Habitat

This deferral alternative would provide more protection for coastal fish habitat by moving drilling and construction noise disturbances and water quality impacts (exploration and production platform discharges, and turbidity) farther away from the Chukchi Sea coastline where estuarine and freshwater salmon EFH exist.

If a large oil spill occurred, the increased distance to the shoreline conceivably reduces the percent chance of one or more spills ≥1,000 bbl contacting sensitive coastal resources. Also, the increased time required for oil to travel this greater distance would conceivably allow for more effective response from spill response depots.

Deferrals could increase the length of pipeline necessary to lay on the seafloor. Increased pipeline distances could result in greater pipeline construction impacts to EFH, and a greater chance for pipeline rupture and subsequent spill. The potential effect categories remain the same as the proposed action, but the anticipated impacts would be lower due to the operations setback from the Chukchi coastline. Overall, the most benefits to nearshore EFH would occur from this alternative because it contains the largest deferral area.

Threatened and Endangered Marine Mammals

Several marine mammals have been recently proposed for listing under the ESA, a group that includes Pacific walrus, bearded seal, and ringed seal. The potential impacts of the Proposed Action on these species remain within the Other Marine Mammals section (below).

This alternative would reduce potential conflicts between migrating bowhead whale populations, bowhead whale subsistence hunters, and offshore oil and gas operations. However, exploration seismic surveys would be allowed to continue in the corridor.

Differences in noise and oil-spill effects on bowhead whales from this deferral compared to Alternative I (Proposed Action) and Alternative IV (Corridor II Deferral) can best be described qualitatively. While the selection of this alternative decreases the opportunity of discovering a commercial field, 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.

This alternative could move sources of industrial noise and sources of crude oil farther 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 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. Observations by Clarke et al. (2011) and satellite tracking by Quakenbush, Citta, and Small et al. (2010) have confirmed use of the deferred area by migrating bowhead whales in the fall. Therefore, bowhead whales could encounter oil and gas-related industrial noise and oil spills in the deferred area. Deferral of this area under Alternative III could make such encounters somewhat less frequent, but bowhead whales would still encounter some attenuated levels of noise from adjacent areas. Ancillary activities such as pipeline associated surveys and construction, support vessel and aircraft traffic to and from shore, and accidental spills would remain the same as described for Alternative I (Proposed Action).

Implementing existing mitigation measures and conservation recommendations in the NMFS Arctic Region Biological Opinion (dated July 17, 2008) would provide the necessary protection to prevent and/or minimize adverse environmental impacts on the bowhead whale from routine activities.

Selecting this alternative would decrease the potential for impacts to polar bears at important denning habitat and barrier islands. The increased distance between offshore development and terrestrial critical habitats could decrease the percent chance that oil could contact polar bears in the event of a spill, increase weathering of spilled oil prior to contact with coastal habitats, and increase available spill-response time. While polar bears prefer offshore sea ice habitat, they are increasingly forced ashore by a lack of sea ice in late summer and fall in the Chukchi Sea. Increased use of the coastline puts them at risk from oil spills and disturbance events onshore. Increasing the deferral area slightly decreases the risk from oil spills and disturbance events onshore, and could provide additional protection to polar bears which prey upon seals within the spring lead system. The FWS has identified barrier islands along the U.S. coast of the Chukchi Sea as Critical Habitat for the polar bear.

Other Marine Mammals

The primary benefit of the corridor provided by this alternative 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 could do the following: decrease the percent chance of spilled oil contacting those marine mammals, like spotted seals and walrus, which tend to use coastal habitats; increase weathering of spilled oil prior to contact with coastal habitats; and increase available spill-response time.

While walrus prefer offshore sea ice habitat, they are increasingly forced ashore by a lack of sea ice in late summer and fall in the Chukchi Sea. The increased use of the coastline by large aggregations of walrus using coastal haulouts, puts them at increased risk from oil spills and disturbance events onshore. Increasing the size of the coastal deferral slightly decreases the risks from disturbance and the potential for oil spills reaching shore for this species. While this may be less true for bearded, ringed and spotted seals, spotted seals aggregate at certain key areas along the Chukchi and Beaufort Sea coasts during the open water season. Additional protection of the nearshore spring lead systems, parts of which would be deferred by the wider coastal corridor, would be beneficial to ringed and bearded seals.

Threatened and Endangered Birds

The yellow-billed loon was classified in 2009 as a candidate species. The potential impacts of the Proposed Action on this species are considered within the Other Marine and Coastal Birds section, below.

Despite a deferral, this alternative 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. 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 LBCHU by molting spectacled eiders. Under this alternative, these activities are less likely to adversely modify the LBCHU compared to Alternative I.

Other 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 farther away from important bird habitats. The increased distance between offshore development and coastal bird habitats could also decrease the percent chance of spilled oil contacting bird habitat, increase weathering of spilled oil prior to contact, and increase available spill-response time.

Terrestrial Mammals

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

Vegetation and Wetlands

The effects of Alternative III would be the same as Alternative I (Proposed Action).

Economy

The effects of Alternative III would be the same as Alternative I (Proposed Action).

Subsistence-Harvest Patterns

This alternative would potentially reduce 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, time for spilled oil to weather and time to mount an oil-spill response would be increased. Consequently, the effects on subsistence-harvest patterns would be expected to be reduced.

Sociocultural Systems

There would be a reduction in the effects on the components of sociocultural systems in comparison to Alternative I (Proposed Action). However, this would not substantially alter the overall effects on sociocultural systems.

Archaeological Resources

The effects of Alternative III would be the same as Alternative I (Proposed Action).

Environmental Justice

The Proposed Action could affect Environmental Justice through 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 relative to those described for Alternative I (Proposed Action). Potential adverse effects are expected to be mitigated substantially, though not eliminated.

Natural Gas Development and Production

The activities associated with natural gas development and production with the most potential to impact the environment (i.e. continued operation of an offshore platform, installation of an offshore and an onshore gas pipeline in the same corridor as existing oil pipelines) are very similar to activities analyzed in the oil exploration, development and production scenario. In general, the deferral corridor proposed in Alternative III would affect potential impacts associated with the natural gas development and production scenario in the same manner as described above, for the oil exploration, development and production scenario. By increasing the minimum distance of the platform to shore, Alternative III could decrease adverse impacts to air quality in coastal areas, nearshore lower trophic level organisms, marine mammals and birds that use the spring lead system and other nearshore areas, subsistence users, and community health. A longer offshore gas pipeline could cause additional impacts to water quality, certain offshore species, etc, but these impacts would be minor. The deferral corridor included in Alternative III would not alter potential impacts associated with other components of the natural gas development and production scenario such as constructing an onshore facility and onshore pipeline.

Impacts of VLOS

In general, environmental impacts from a VLOS occurring under Alternative III are very similar to those from a VLOS occurring under Alternative I.

There are two principal manners in which potential impacts may differ as between Alternative III and Alternative I. First, by implementing a 60-mile deferral corridor, selecting Alternative III would reduce the area of the Chukchi Sea made available for oil and gas activities under Sale 193. To the extent that spilled oil from a VLOS occurring in this area is more likely (as compared to a VLOS occurring in other portions of the lease sale area) to contact important resource areas, a deferral could reduce the potential for adverse impacts to resources in nearshore and coastal areas. Benefits could accrue to nearshore and coastal water quality, certain species of fish, beluga whales, polar bears, many species of birds, certain species of seals, walrus, terrestrial mammals, and communities that depend on subsistence. Second, deferring additional areas along the coastward edge of the sale area increases the minimum potential distance between a VLOS and shore, which could allow more time and space for spill response and cleanup activities in the event of a VLOS. This could reduce the extent of nearshore and onshore contact by spilled oil.

II.D.4. Summary of Impacts: Alternative IV – Corridor II Deferral

The major difference between Alternative IV (Corridor II deferral) and Alternative I (the Proposed Action) is that the blocks within the deferral area would not be offered for lease under Alternate IV. Exploration seismic surveying, ancillary activities along potential pipeline routes, and installation of a pipeline to shore could still occur within the deferral corridor. No exploration or development drilling or platform construction would occur within the deferred area.

This deferral corridor would increase the minimum distance from shore in terms of the following:

- Length of oil and gas pipelines from a platform to shore
- Travel distances for vessels and aircraft supporting exploration and development drilling activities and platform construction and operations
- Discharges, emissions, and noise associated with drilling and platform installation and operation could occur
- The source of a VLOS

The deferral area (Corridor II) under Alternative IV is narrower (i.e., defers fewer blocks) than the deferral area (Corridor I) under Alternative III. The minimum distance from shore for activities listed above is longer under Alternative III (60 miles) as compared with Alternative IV (30 miles).

Summaries of potential impacts under Alternative IV are presented first for the oil exploration, development, and production scenario analyzed in the Sale 193 FEIS (USDOI, MMS, 2007a), then for the natural gas development and production scenario analyzed in sections IV.B and IV.C, and lastly for the VLOS scenario analyzed in sections IV.D and IV.E.

Oil Exploration, Development, and Production

Water Quality

The level of potential activities remains the same for Alternative I, III, or IV; therefore, the actions and sources of water quality degradation do not change. The deferral areas may avoid localized discharges to marine waters; however, the removal of the deferred lease blocks would not significantly change the effects on marine water quality either negatively or beneficially. Permitted discharges that are compliant with granted permits would not pose a significant degree of risk to water quality,at the various proposed development and production sites.

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 potential air quality impacts, however, is small.

Lower Trophic Level Organisms

The effects of Alternative IV would be the same as Alternative I (Proposed Action).

Fish Resources

The primary benefit of Alternative IV is that it would move sources of potential effects farther away from important coastal and anadromous fish habitats. The increased distance between offshore development and coastal fish habitats could also conceivably decrease the chance of spilled oil contacting the coastline, increase the time for weathering of spilled oil prior to contact, and increase the 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, 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, and sediment plumes) farther 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 noise and contaminant effects farther away from important coastal and anadromous fish habitats. The increased distance between offshore development and coastal fish habitats could also decrease the percent chance of spilled oil contacting nearshore fish habitats, increase the weathering of spilled oil prior to contact, and increase the spill-response time.

Threatened and Endangered Marine Mammals

Several marine mammals have been recently proposed for listing under the ESA, a group that includes Pacific walrus (designated as a candicate species in 2010), bearded seal (proposed for listing in 2010), and ringed seal (proposed for listing in 2010). The potential impacts of the Proposed Action on these species remain within the Other Marine Mammals section (below).

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 a much as Alternative III) potential conflicts between migrating bowhead whale populations, bowhead whale subsistence hunters, and offshore oil and gas operations. Exploration seismic surveys would be allowed to continue within the corridor.

Differences in noise and oil-spill effects on bowhead whales from this deferral compared to Alternative I (Proposed Action) and Alternative III (Corridor I Deferral) are difficult to quantify. 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 for Alternative I (Proposed Action), 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; 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). Observations by Clarke et al. (2011) and satellite tracking by Quakenbush, Citta, and Small et al. (2010) have confirmed use of the deferred area by migrating bowhead whales in the fall. Therefore, bowhead whales could encounter oil and gas-related industrial noise and oil spills in the deferred area. Deferral of this area under Alternative IV could make such encounters somewhat less frequent, but bowhead whales would still encounter some attenuated levels of noise from adjacent areas. Ancillary activities such as pipeline associated surveys and construction, support vessel and aircraft traffic to and from shore, and accidental spills would remain the same as described for Alterative I (Proposed Action).

Selecting Alternative IV would also decrease the potential for impacts to polar bears at important denning habitat and barrier islands, though to a lesser extent than Alternative III. As in Alternative III, Alternative IV could increase the distance between offshore development and terrestrial critical habitats which could decrease the percent chance that oil would contact polar bears in the event of a spill, increase weathering of spilled oil prior to contact with coastal habitats, and increase available spill-response time.

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 farther away from important coastal habitats. The increased distance between offshore development and coastal habitats could do the following: slightly decrease the percent chance of spilled oil contacting those marine mammals, like spotted seals, which tend to use coastal habitats; increase weathering of spilled oil prior to contact with coastal habitats; and increase available spill-response time.

Threatened and Endangered Birds

The yellow-billed loon was recently classified as a candidate species. The potential impacts of the Proposed Action on this species are considered within the Other Marine and Coastal Birds section, below.

Despite a deferral, this alternative could present new (but potentially fewer than Alternative I) 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 LBCHU by molting spectacled eiders. Under this alternative, these activities are less likely to adversely modify the LBCHU compared to Alternative I.

Other Marine and Coastal Birds

This alternative has a smaller deferral area than Alternative III. The primary benefit of this deferral 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 could also 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.

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 farther 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

The effects of Alternative IV would be the same as Alternative I (Proposed Action).

Economy

The effects of Alternative IV would be the same as Alternative I (Proposed Action).

Subsistence-Harvest Patterns

This alternative would potentially reduce 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, time for spilled oil to weather and time to mount an oil-spill response would be increased. Consequently, reduced effects on subsistence-harvest patterns would be expected. 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

There would be a reduction in effects on the components of sociocultural systems in comparison to Alternative I (Proposed Action). However, this would not substantially alter the overall effects on sociocultural systems.

Archaeological Resources

The effects of Alternative IV would be the same as Alternative I (Proposed Action).

Environmental Justice

The Proposed Action could affect Environmental Justice through 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.

Natural Gas Development and Production

The activities associated with natural gas development and production with the most potential to impact the environment (i.e. continued operation of an offshore platform, installation of an offshore and an onshore gas pipeline in the same corridor as existing oil pipelines) are very similar to activities analyzed in the oil exploration, development and production scenario. In general, the deferral corridor proposed in Alternative IV would affect potential impacts associated with the natural gas development and production scenario in the same manner as described above, for the oil exploration, development and production scenario. By increasing the minimum distance of the platform to shore, Alternative IV could decrease adverse impacts to air quality in coastal areas, nearshore lower trophic level organisms, marine mammals and birds that use the spring lead system and other nearshore areas, subsistence users, and community health. A longer offshore gas pipeline could cause additional impacts to water quality, certain offshore species, etc, but these impacts would be minor. The deferral corridor included in Alternative IV would not alter potential impacts associated with other components of the natural gas development and production scenario such as constructing an onshore facility and onshore pipeline.

Impacts of VLOS

In general, environmental impacts from a VLOS occurring under Alternative IV are very similar to those from a VLOS occurring under Alternative I.

There are two principal manners in which potential impacts may differ as between Alternative IV and Alternative I. First, by implementing a deferral corridor, selecting Alternative IV would reduce the area of the Chukchi Sea made available for oil and gas activities under Sale 193. To the extent that spilled oil from VLOS occurring in this area is more likely (as compared to a VLOS occurring in other portions of the lease sale area) to contact important resource areas, a deferral could reduce the potential for adverse impacts to resources in nearshore and coastal areas. Benefits could accrue to nearshore and coastal water quality, certain species of fish, beluga whales, polar bears, many species of birds, certain species of seals, walrus, terrestrial mammals, and communities that depend on subsistence. Second, deferring additional area along the coastward edge of the sale area increases the minimum potential distance between a VLOS and shore, which could allow more time and space for spill response and cleanup activities in the event of a VLOS. This could reduce the extent of nearshore and onshore contact by spilled oil.

Because Alternative IV defers a relatively small area over what is already deferred via the 25 Statute Mile Buffer implemented in the Final OCS Leasing Program for 2007-2012 and incorporated into Alternative I, its potential to reduce impacts from a VLOS event above the potential reductions from Alternative I is small.

Chapter III

Description of the Environment

CHAPTER III. Description of the Environment

The following sections summarize the description of the physical, biological, and socioeconomic conditions and resources from the Sale 193 FEIS. The organization of this chapter is consistent with Chapter III of the Sale 193 FEIS. Most numbered headings have been retained as designated in the Sale 193 FEIS for ease of reference.

This section also provides additional information about the affected environment where it is relevant to understanding potential effects from natural gas development and production and/or a VLOS (very large oil spill). Most of this additional information is new information which became available subsequent to the publication of the Sale 193 FEIS in 2007. Many of the additional studies referenced in this chapter were identified by BOEMRE analysts during their ongoing review of current scientific literature. Others were suggested for incorporation by stakeholders, government agencies, and public commenters. Discussion of additional data, studies, regulatory changes, etc. is provided within subsections titled “New Information for SEIS Analysis.” Where no important new information was identified for a particular environmental condition or resource, a statement to that effect is provided. Of all the additional information reviewed for this Final SEIS, none was found to alter the analysis or conclusions regarding oil exploration, development and production in the Sale 193 FEIS.

Changes in the regulatory status of certain species under the ESA are acknowledged within the Threatened and Endangered species sections. For the sake of consistency with the Sale 193 FEIS, background description for newly-proposed (but not yet “listed”) species is retained within the Other Marine Mammals and Other Marine and Coastal Birds subsections of this Chapter.

For a more detailed discussion of the environmental conditions and resources in the Sale 193 area, including maps, readers are directed to the Sale 193 FEIS (USDOI, MMS, 2007a, incorporated by reference).

III.A. Physical Environment

III.A.1. Physiography

The Chukchi Sea is located in the Arctic Ocean northwest of the Alaska Arctic coast. The Chukchi Sea Planning Area overlies a broad, low-relief continental shelf that is gently inclined to the north. Approximately 98% of the Sale 193 area covers this relatively shallow continental shelf adjacent to the Arctic Ocean. Approximately 80% of the continental shelf lies between the 95 and 200 ft (30 and 60 m) isobaths (Grantz et al., 1982). Nearshore areas (shallower than 40 m) exhibit complex bathymetry characterized by ridges and troughs. Hanna Shoal within the Sale 193 area and Herald Shoal to the west side rise above the surrounding seafloor to approximately 20 m below sea level. There are also two major sea valleys in the Chukchi Sea: Herald Canyon and Barrow Canyon.

The shoreline west of Barrow is characterized by nearly continuous sea cliffs up to 12 m high and cut into perennially frozen ice-rich sediments. Near Icy Cape and Point Franklin offshore barrier islands along the coast enclose shallow lagoons. Elsewhere the cliffs are abutted by narrow beaches. The Arctic Coastal Plain (ACP) is flat near the coast, and gradually increases in relief to the south towards the foothills of the Brooks Range (Figure 5).

New information for SEIS analysis

No new information regarding physiography has been introduced in this Final SEIS.

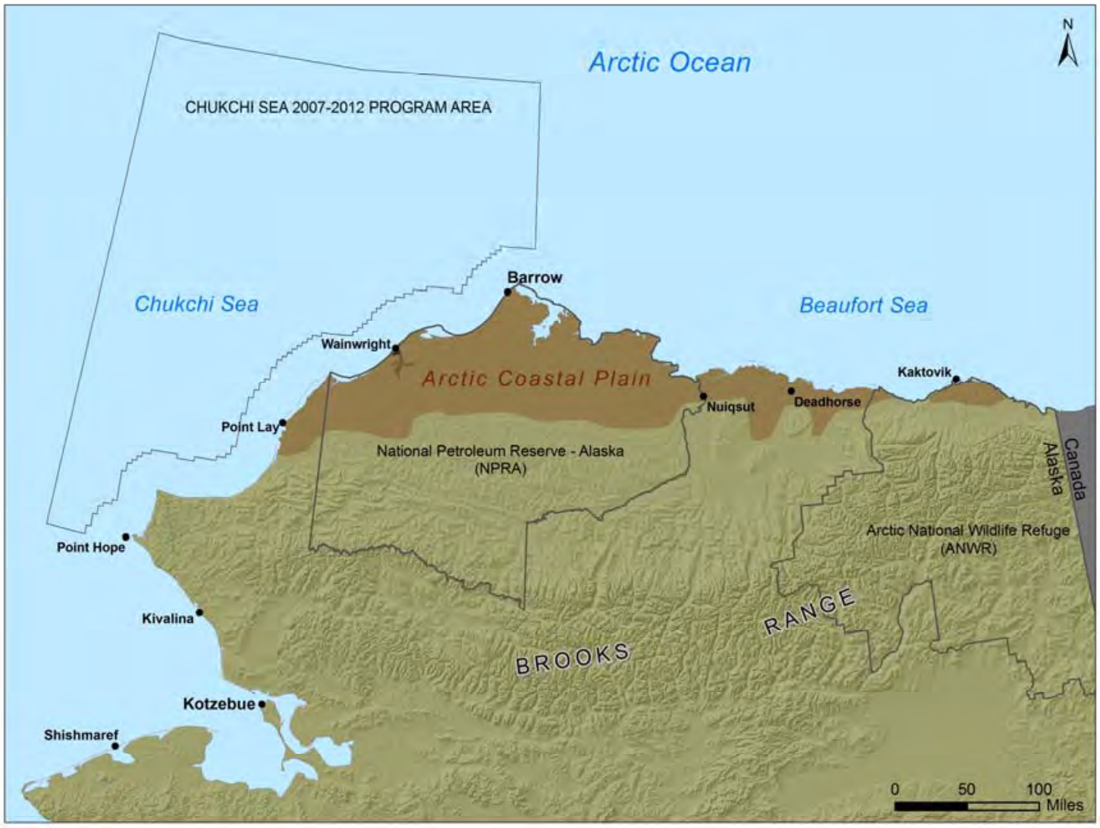

Figure 5. The Arctic Coastal Plain is a low tundra and wetland region stretching along the northern coast of Alaska, and south to the Brooks Range. It is included in portions of the NPR-A and ANWR.

III.A.2. Climate and Meteorology

The Chukchi Sea is an Arctic climate characterized by moderate winds, cold temperatures during the winter, cool temperatures in the summer, and little annual precipitation. 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. During the winter, winds can be strong and prolonged, leading to extreme ice pressures and dangerous wind-chill conditions. A brief warm and snow-free season follows in June, July, and August.

New information for SEIS analysis

The Arctic has seen very large cyclical variations over the past 2 million years. The changes have not been uniform over the area. Large changes also have taken place abruptly, spanning just a few decades. The driving factors are complex but involve changes in solar radiation, atmospheric circulations, ocean circulations, and the cryosphere. The Arctic Mulitple-Sale Draft EIS (USDOI, MMS, 2008a) provides a summary discussion of 20th century climate trends, variability, and projected changes to climate in the Arctic. The assessments of climate change and effects in the Arctic given in the Arctic Multi-Sale Draft EIS are based on the 2007 publication by the Intergovernmental Panel on Climate Change (IPCC, 2007) and the Arctic Research Center's Arctic Climate Impact Assessment (2005). These two reports are considered to include the most thorough scientific evaluation of climate change (Karcher, 2010).

The Arctic climate is undergoing changes as a result of global climate change as well as natural cyclical variations. The Arctic Climate Impact Assessment (ACIA, 2005) summarized spatial and temporal temperature trends in the Arctic based on observations from the Global Historical Climatology Network database (Peterson and Vose, 1997) and the Climate Research Unit database (Jones and Moberg, 2003). The greater amount of warming in the Arctic compared to that for the globe as a whole is consistent with climate model projections (IPCC, 2007). In general, temperatures increased from 1900 to the mid-1940s, decreased until about the mid-1960s, and then increased again up to the present. From 1966-2003, the average rate of temperature change for the Arctic was 0.40 °C (0.7 °F) per decade (ACIA, 2005). When temperature trends are broken down by season, the largest changes occurred in winter and spring.

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

A trend analysis for first-order observing stations in Alaska for the period of 1949-2007 shows an average temperature change of 1.9 °C (3.4 °F). The largest increase was seen in winter and spring, with the smallest change in autumn. The trend has been far from linear. There was a decrease in temperature in the period from 1949-1976 followed by an abrupt increase in temperature in the period from 1973-1979. Since 1979, only a little additional warming has occurred in Alaska with the exception of Barrow and a few other locations (Rigor, Colony, & Martin, 2000).

Concurrent with climate change is a change in ocean chemistry known as ocean acidification. This phenomenon is described in the IPCC Fourth Assessment Report (Climate Change 2007), a 2005 synthesis report by members of the Royal Society of London (Raven, Caldeira, Elderfield et al., 2005), and an ongoing BOEMRE-funded study (Mathis, 2011). The greatest degree of ocean acidification worldwide is predicted to occur in the Arctic Ocean. This amplified scenario in the Arctic is due to the effects of increased freshwater input from melting snow and ice, and from increased CO^2 uptake by the sea as a result of ice retreat (Fabry et al., 2009). Measurements in the Canada Basin of the Arctic Ocean demonstrate that over 11 years, melting sea ice forced changes in pH and the inorganic carbon equilibrium, resulting in decreased saturation of calcium carbonate in the seawater (Yamamoto-Kawai, 2009). Bates et al. (2009) showed the effects of decreasing pH on the saturation states of inorganic carbonate in the Chukchi and Beaufort seas, and the interaction of carbonate states with primary productivity.

Precipitation in the Arctic exhibits an upward trend, consistent with what is observed in mid-latitudes. Mean annual precipitation in the Arctic has increased at the rate of 1.4% per decade in the period from 1900-2003 and at a rate of 2.2% per decade in the period from 1966-2003 (ACIA, 2005). A few studies also indicate that an increasingly larger portion of precipitation falls in the form of rain (ACIA, 2005).

Climate change in the Arctic is projected to be larger than in other areas of the globe (ACIA, 2005). However, Arctic climate has a larger natural variability and is highly complex and, therefore, climate projections may have greater uncertainty. Of all the parameters, sea level rise has the largest uncertainty.

III.A.3. Physical Oceanography

The physical oceanography in the Chukchi Sea Planning Area is influenced by: (1) flow of water through the Bering Strait and the Siberian Coastal Current; (2) atmospheric-pressure systems; (3)

surface-water runoff; (4) density differences between watermasses; and (5) seasonal and perennial sea ice. Flow in the Chukchi Sea generally is northward from the Bering Strait and, in general, is topographically steered (Figure 6). 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). 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. Tides are small in the Chukchi Sea, generally <0.3 m. Tidal currents are largest on the western side of the Chukchi and near Wrangel Island, ranging up to 5 cm/s (USDOI, MMS, 2007a; Woodgate, Aagaard, and Weingartner, 2005). Storm surges are both positive and negative.

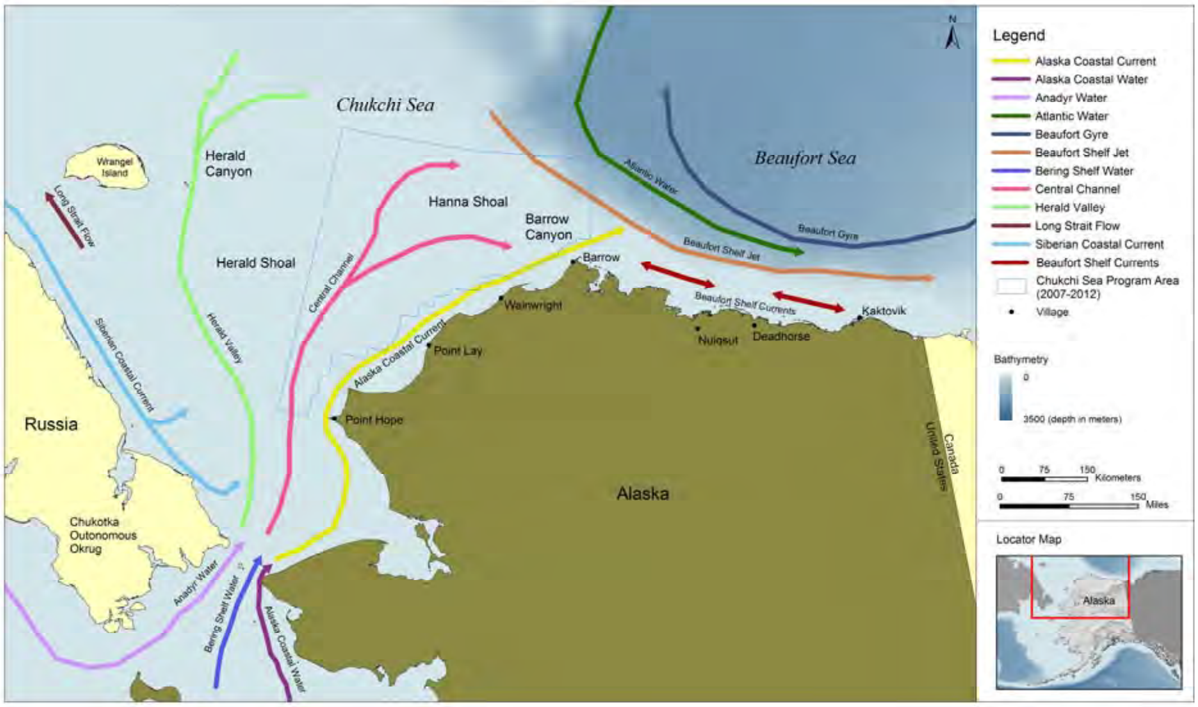

Figure 6. Generalized current circulation over the Chukchi and Beaufort seas.

New information for SEIS analysis

Recent tide gauge observations at Barrow show coastal water levels are driven primarily by wind stress and barometric pressure changes from the passage of storm centers and frontal passages (Gill, Sprenke, and Kent et al., 2011). Storm surge on the coast and coastal water level withdrawl can be significant (about 1.0 m amplitude; Gill, Sprenke, and Kent et al., 2011). Highest monthly sea levels are are generally in August and lowest monthly mean sea levels are in March. Winds from the west are associated with positive surges, and winds from the east are associated with negative surges. In late fall, the lack of sea ice increases the open-water area enhancing water transport and increasing wave height (Lynch and Brunner, 2007).

High frequency radar mapping of surface currents suggests that the circulation may consist of transitory mesoscale circulations, including eddies with diameters of ~20 km. These appear most frequently at the head of Barrow Canyon and to the east of Hanna Shoal. The HFradar data indicates a strong coastal jet within about 25km of the coast offshore of Wainwright, with speeds over 50 cm/s and varying rapidly in response to the winds (Potter et al., 2010).

III.A.4. Sea Ice

There are three general forms of sea ice in or adjacent to 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, and moves under the influence of winds and currents. These general ice types vary spatially and temporally in the Chukchi Sea Planning Area and are strongly influenced by the bathymetry and location of offshore shoals as well as 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.

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). The summer melt pattern primarily is influenced by the influx of warmer water from the Bering Sea. Melt-onset begins in early May in the southern portion of the Sale 193 area and early to mid June in the northern portion. By about mid-May, the nearshore ice and thin ice begin to melt; by July, the pack ice begins retreating northward. At the height of summer (mid-September in the Arctic), the Chukchi is normally 80% free of ice (Mulherin, Sodhi, and Smallidge, 1994). 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).

The Arctic sea ice is undergoing changes in extent, thickness, distribution, age, and melt duration (Stroeve et al., 2005; NASA, 2005; Comiso, 2006). The analysis of long-term data sets indicates 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.

Landfast Zone

The mean annual cycle of landfast ice begins in October and grows slowly through February. First ice appears anywhere from late October to late December. Stable landfast ice appears from mid-January to mid-March. In the shallow (2 m and less), inner part of the landfast zone, the ice freezes to the seafloor; in the outer part, the ice floats. Thawing begins about late May, and breakup occurs from about late May to mid-June. Overall there is a gradual formation of landfast ice and a rapid retreat.

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 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).

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 Planning Area generally moves in a westerly direction. Pack ice in the southern part of the Planning Area is usually transported to the north or northwest.

Sea ice thicker than 5 m is common in the Arctic Ocean pack ice.

Chukchi Sea Open-Water System

A large polynya (or a series of polynyas) develops between the landfast- and pack-ice zones extending the length of the Chukchi coast from Point Hope to Barrow during the winter and spring (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 May and June, the average width of the open-water system is about 4 km at the northern end (toward Barrow) but widens to about 100 km at the southern end (toward Point Hope). September is the period of maximum open water; the freezeback process begins in October. General locations for polynyas in this region are illustrated in the Sale 193 FEIS (Figure III.A-14).

Ice Gouging

At depths shallower than 60 m, linear depressions have been gouged into the seafloor by the keels of drifting ice masses. 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, possibly a reflection of the thin sediment cover. Contemporary ice gouging may be occurring in water at least 43 m deep. In the central part of the Sale 193 area, ice gouges were observed cutting across sand-ripple fields that may be active under present-day current regimes.

BOEMRE has collated available ice-gouge and strudel-scour data from site-specific exploration and development surveys in the Beaufort Sea and is just beginning this effort in the Chukchi Sea. Required site-specific surveys in support of proposed drilling or production activities in the Chukchi Sea will provide information on ice gouging in the local area before decisions are made on specific proposed activities, and will be added to the collated data base.

New information for SEIS analysis

Satellite data have shown that Arctic March sea-ice extent has decreased by about 2.7% per decade during the period 1979 through 2010 (Perovich et al., 2010). This decreasing trend is observed in all seasons, but the greatest decrease is found in September with a trend of -11.5% per decade (NSIDC, 2010a). The 2010 minimum (Figure 7) was the third lowest year for ice extent following 2008 and 2007 (NSIDC, 2010b). In September 2007, Arctic sea-ice extent reached its lowest value since satellite measurements began in 1979, and was 23% lower than the previous record established in 2005 (NSIDC, 2007). The causes of the decline in sea ice are thought to be attributed to many variables, including a rise in air temperatures, changes in radiative fluxes from increases in greenhouse gases, and changes in atomospheric circulation and warming ocean temperatures (Overland and Wang, 2010; Woodgate, Weingartner, and Lindsay, 2010).

Sea-ice extent predictions, using several climate models and taking the mean of all the models, estimate that the Arctic will be ice free during summer in the later part of the 21^{st} century (IPCC, 2007). There is considerable uncertainty in the estimates of summer sea ice in these climate models, with some predicting 40–60% summer ice loss by the middle of the 21^{st} century (Holland, 2006). Using a suite of models, a 40% loss is estimated for the Beaufort and Chukchi seas (Overland and Wang, 2007). Some investigators, citing the current rate of decline of the summer sea ice extent, believe it may be sooner than predicted by the models and may be as soon as 2013 (Stroeve et al., 2008). Other investigators suggest that variability at the local and regional level is very important for making estimates of future changes. Generally, it is thought that the Arctic will become ice free in the summer, but at this time there is considerable uncertainty about when that will happen (Stroeve et al., 2011, Tietsche et al., 2011, Zhang, Steele and Schwiger 2010, Overland and Wang, 2010).

A) Left map and graph **B) Right map and graph**

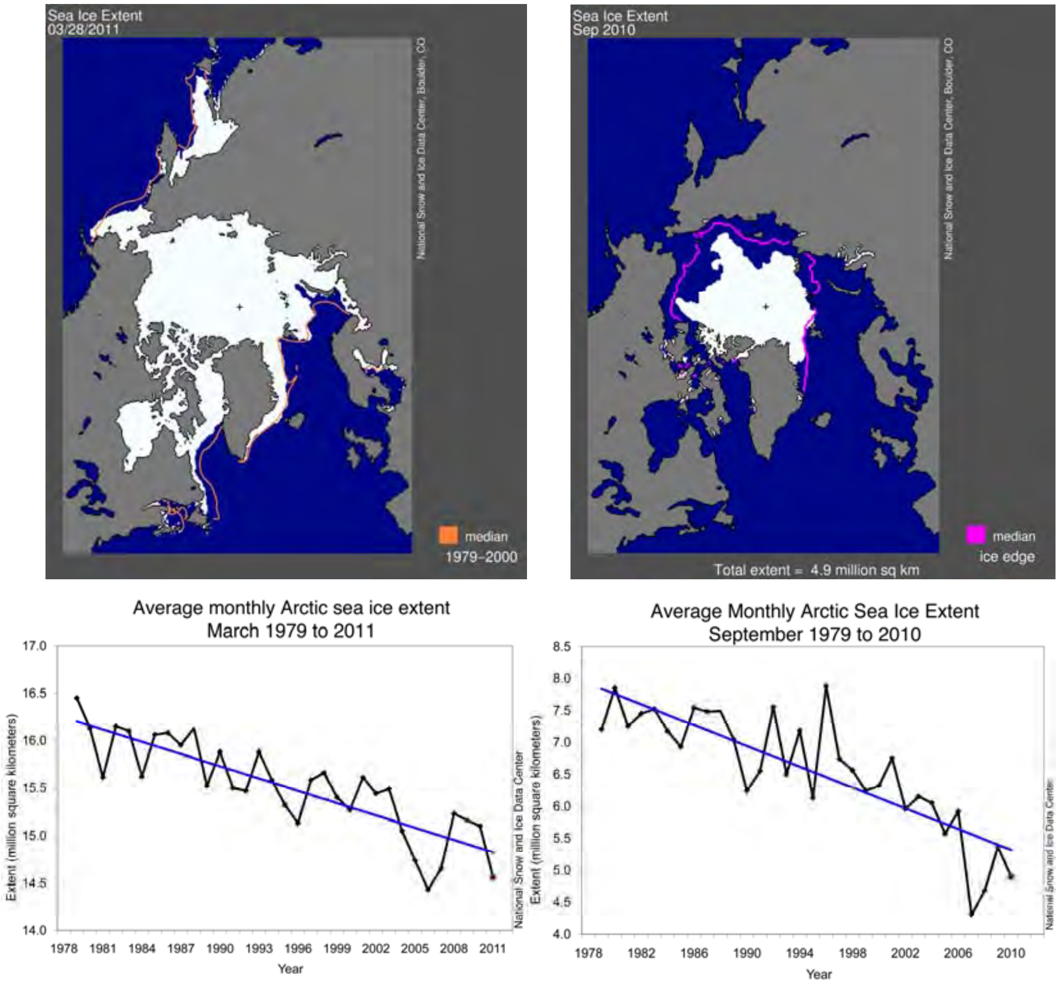

Figure 7. A) Map shows the maximum sea ice extent (in white) for March 2011, and also the median sea ice extent (red line) for the period 1979–2000. Graph shows the average monthly sea ice extent over the period 1979–2011. B) Map shows the minimum sea ice extent (in white) for September 2010, and the median sea ice extent (red line) for the period 1979–2010. Graph shows the average monthly sea ice extent over the period 1979–2010.

III.A.5. Water Quality

Water quality describes the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose. Important water column properties include temperature, salinity, and density.

Due to very limited development in its watersheds, the U.S. Chukchi Sea experiences little nonpoint source pollution runoff. Industrial impacts are minimal and potential degradation of the Arctic OCS water quality is confined primarily to inputs, such as nearshore discharges of treated wastewaters from coastal communities and the long-range transport of various global contaminants. Marine water quality conforms to the U.S. Environmental Protection Agency (USEPA) criteria for the protection of marine life. 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).

Local water quality is largely related to seasonal biological activity and naturally occurring processes, such as water-column stratification due to temperature differentials, seasonal plankton blooms (primarily in spring and fall), naturally occurring oil/hydrocarbon seeps, seasonal changes in water turbidity due to terrestrial runoff, formation of surface water ice, and natural erosion of organic material along the shorelines. The main rivers that flow into the U.S. Arctic marine environment remain relatively unpolluted by human activities.

New information for SEIS analysis

The potential for ocean acidification in the marine environment is a concern in the Chukchi Sea. As carbon dioxide (CO_2) increases in the atmosphere, the ocean absorbs more CO_2. This increase in CO_2 in seawater forces an increase in hydrogen ion concentration while lowering the pH and bioavailability of $CaCO_3$ over time. This topic was introduced in Section III.A.2 and will be further discussed in Chapter V, Cumulative Effects.

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).

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 substantial 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.

New information for SEIS analysis

No new information regarding air quality has been introduced in this Final SEIS.

III.A.7. Acoustic Environment

Ambient sound levels in the Chukchi Sea can vary dramatically between and within seasons as a result of the following: (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. Ambient sound levels can affect whether a specific sound is detectable by a receiver, including a living receiver. Burgess and Greene (1999) measured ambient sound in the Beaufort Sea in September to be approximately 63 to 133 dB re 1 µPa.

In the Chukchi Sea, natural sources of marine sound include 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. At least seasonally, animals can also contribute significantly to the background sound in the acoustic environment of the Chukchi Sea.

Human sources of sound in the marine environment include vessels (motor boats used for subsistence and local transportation, commercial shipping, research vessels, etc.); navigation and scientific research equipment; airplanes and helicopters; human settlements; military activities; and marine development.

New information for SEIS analysis

No new information regarding the acoustic environment has been introduced in this Final SEIS.

III.B. Biological Environment

III.B.1. Lower Trophic Level Organisms

The Chukchi Sea is generally thought of as having the highest benthic faunal mass of all the Arctic shelves (Grebmeier and Dunton, 2000; Dunton et al., 2005). This biomass is relatively high in the northeastern Chukchi Sea when compared to the central and western Chukchi Sea (Grebmeier and Dunton, 2000). Grebmeier and Dunton (2000) explain this richness is due in part to nutrient availability from large amounts of organic matter sinking to the seafloor in these areas. A review paper by Grebmeier et al. (2006), synthesizing some 20 years of data from interdisciplinary oceanographic cruises, found there are areas of high benthic biomass and abundance in the south central and northeastern Chukchi Sea. Primary productivity in the Chukchi Sea is higher near the Bering Strait, along the Russian Chukotka coast, around Point Hope and Cape Lisburne, and along the Alaskan coast, including Ledyard Bay. Primary productivity is probably high within the Sale 193 area during the early summer retreat of the ice edge. During midsummer, primary productivity generally is low and relatively uniform within the Sale 193 area. Several kelp communities present in the Chukchi Sea are located only inshore of the Sale 193 area; their spatial extent is probably limited by the presence of rock and other hard substrate.

New information for SEIS analysis

The Sale 193 FEIS explains why the oil exploration, development and production scenario would only cause localized and temporary impacts to lower trophic level organisms. Section IV.B.3 of the Final SEIS concludes that any impacts to these resources from the natural gas development and production scenario would likewise be localized and temporary. In contrast, a VLOS could impact lower trophic communities and organisms on a much broader scale. To better understanding the potential impacts to lower trophic level organisms from a VLOS, it is useful to elaborate on the existing background discussion of the Sale 193 FEIS. Additional detail regarding lower trophic level organisms in the Chukchi Sea is therefore provided here.

The term lower trophic organism refers to numerous species, and includes those animals, plants, algae, and bacteria that constitute the primary and sometimes secondary trophic levels of the ecological communities found within the affected environments described in this Final SEIS. Communities may have one or more trophic levels, with each level consisting of one or more species existing by consuming a species or group of species in the trophic level beneath it (Levinton, 1982). The exception to this rule is the primary production or primary trophic level, consisting of organisms that fix carbon through photosynthesis or chemosynthesis. There are three separate communities, or groups of organisms, that coexist in similar niches within the described environments that are of special concern to this analysis: pelagic communities, benthic communities, and epontic communities. The pelagic community comprises two loosely defined groups that make up the organisms living in the open water, those living at or near the surface (sometimes referred to as the neuston), and those living within the pelagic realms of the water column. The benthic community consists of both the epifauna (those living just above but still strongly associated with the benthos) and the infauna (those living within the sedimentary layers of the benthic surface). The epontic community consists of lower trophic those organisms living on and in the sea ice.

Pelagic Communities

The neuston make up the planktonic assemblages, consisting primarily (by numbers of individuals) of phytoplankton, with the remainder consisting mostly of metazoan animals living within the planktonic mass and collectively known as the zooplankton (Levinton, 1982). Each spring and summer, the Chukchi Sea typically experiences a short but intense phytoplankton bloom that is temporally controlled by sea ice cover, nutrient availability, and river runoff. Phytoplankton populations making up those blooms in the Chukchi Sea are representative of a complex ecosystem where distinct water masses of Pacific Ocean origin come together. These contributions consist of north Pacific current waters pushing northeastward and influencing Alaska coastal, Bering shelf, and Anadyr waters, each with their own unique assemblages of phytoplankton and nutrients, that are moved into the Chukchi Sea by the processes of advection (Hopcroft, Kosobokova, and Pinchuk, 2010, as stated in Hopcroft, Questel, and Clarke-Hopcroft, 2010). Collectively these waters contribute an estimated 1.8 million metric tons of phytoplankton that are forced across the Bering Sea and into the Chukchi Sea annually (Springer, McCroy, and Turco, 1989). The Chukchi zooplankton fauna is also primarily of Pacific origin, particularly during the ice-free months (Hopcroft, Questel, and Clarke-Hopcroft, 2010). The diversity and abundance of species, families, and phyla found within the zooplankton of the Chukchi Sea are reflective of the productivity and diversity of the phytoplankton and their waters of origin (Dunton et al., 2005, Grebmeier et al., 2006). Ichthyoplankton (fish larvae living and feeding temporarily within the planktonic mass), such as Arctic cod (Boreogadus saida), are commonly found in plankton samples (Norcross et al., 2010). Meroplankton (animals that spend only part of their life cycles within the planktonic masses, typically the larvae of benthic or open pelagic animals) are represented by larval stages of diverse organisms including polychaetes, cnidarians, and most arthropods known in Arctic waters including opilio crabs, barnacles, copepods, mysids, and euphasiids (Brusca and Brusca, 2003). Nauplii larvae of resident copepods (known as holoplankton, and living their entire developmental cycle within the planktonic masses) are diverse and abundant. Copepods are well represented in planktonic masses of Arctic waters including numerous calanoid copepod genera, including the Oithona, Oncaea, Calanus, Microcalanus, and Pseudocalanus. Copepods are essential to the food webs of the Arctic, being important prey of organisms as diverse as Arctic cod and bowhead whales (Bluhm and Gradinger, 2008). Further down in the water column, pelagic communities consist of organisms that are found throughout the relatively shallow waters of the region (Hopcroft, Bluhm, and Gradinger, 2008). Within the Chukchi Sea and adjoining basin there is considerable diversity of both small and large squid, jelly fish, hydromedusae and ctenophores. Abundant populations of larvaceans (free-living urochordates, or tunicates), particularly the large (approximately 7 mm) Arctic species *Oikopleura vanhoeffeni* are found throughout the Chukchi Sea (Lane et al., 2008). The biomass of larvaceans may rival that of the copepods, particularly at ice-edge collection stations where some of the highest recorded densities for *O. vanhoeffeni* have been observed. Pteropods, or pelagic molluscs, are often abundant and represent an important component of biomass in the region (Hopcroft, Questel, and Clarke-Hopcroft, 2010).

Benthic Communities

Chukchi sea benthic communities are among the most abundant and diverse in Arctic regions due to the primary productivity created by phytoplankton populations (Grebmeier, 2006). As the spring and summer plankton blooms recede and the release of carbon from ice melt and subsequent release of material from epontic communities occur, the passive downward drift of nutrients fuels the benthic communities (Dunton et al., 2006; Quijon, Kelly, and Snelgrove, 2008). The south-central Chukchi Sea has the highest algal and faunal biomass on the combined Bering Sea shelf and southern Chukchi Sea (Grebmeier 1993; Feder et al., 2007). Kelp beds (communities dominated by the large kelp Laminaria solidungula) occur in at least two areas along the coast. One first described by Mohr, Wilimovsky, and Dawson (1957) and confirmed by Phillips et al. (1982) is located about 20 km northeast of Peard Bay near Skull Cliff. Another was reported by Phillips and Reiss (1985) approximately 25 km southwest of Wainwright. The known kelp beds are located relatively close to the coast in Alaska State waters. These unique biological communities consist of bottom substrates dominated by cobblestone or rock that exhibit highly diverse epifaunal communities of isopod, copepod, amphipod, shrimp, and molluscs. The Ledyard Bay Critical Habitat Area is south of these areas (see Figure 1 and the marine and coastal bird section of this document for a description of this habitat). A benthic ecology study by Blanchard, Nichols, and Parris (2010) involved the sampling of benthic communities at the Burger and Klondike drill sites. Benthic fauna in both exploration sites were abundant and diverse, and unique in their respective compositions. They found the two sites exhibited differences in substrate composition, water depth, and both infaunal and epifaunal community compositions. Starting at the southeast corner of Klondike and moving into the northwest corner of Burger, abundance and diversity of benthic communities, percentage of mud in the substrate, and water depth all increase. Infaunal biota were more diverse and abundant than epifaunal communities. Representatives from 383 taxonomic categories of infauna and 19 genera of epifauna were identified. Polychaetes and burrowing or tube-dwelling amphipods dominated the infaunal communities: 48% were polychaete worms, 30% were crustaceans (mostly amphipods and cumaceans), and 19% were molluscs (clams and snails). Epifaunal communities were dominated by brittle and sea stars, and also included sea cucumbers, snails, tunicates, barnacles, and crabs (refer to Figure 3-8, p. 51 in USGS, 2011).

Epontic Communities

Sea ice is an essential driver of the ecosystems in the Chukchi Sea (Gradinger, 2008). Epontic communities inhabit a three-dimensional network of brine channels between the ice crystals in fast and pack ice, or the undersurface, hard bottom substrate of the ice-water interface (Horner 1985). The spatial and temporal variability of biological sea ice parameters occurs on various scales which are directly linked to environmental variables, in particular light availability and nutrient supply, which in turn is influenced by snow cover, ice morphology and microstructure, and sediment incorporation (Junge et al., 2004, Gradinger 2008). Lee et al. (2003) found ice algae contributed 74% of under-ice pelagic productivity during winter months of no photosynthetically active radiation, performing a sustaining capacity in the environment enabling survival of pelagic and benthic communities. Epontic communities are often highly diverse and consist of numerous crustaceans (dominated by amphipods and euphasiids), larval polychaetes, and nematodes. Gammaridean amphipods may exist at numbers of >1000/m2. They are the dominant macrofaunal taxon in the Arctic under-ice habitat and the best studied consumers of ice algal production in the Arctic (Gradinger and Bluhm, 2004). The organic matter produced within the sea ice serves as the base for the ice-associated food web including protozoans and metazoans, which are represented by ciliates, rotifers, copepods, copepod nauplii, nematodes, turbellarians, and, in the case of offshore fast ice, larvae of benthic polychaetes and gastropods (Horner 1985). Meiofauna abundances decrease as one moves from the nearshore ice (up to 350,000 animals/m2) to the deep-sea basin by about three orders of magnitude (Gradinger and Bluhm, 2005; Gradinger et al., 2005). Although a variety of ice meiofauna and metazoan larvae consume ice algae, only a fraction (>10%) of the ice algal production is consumed by them (Gradinger et al., 2005). The remainder provides nutrients to the under ice environment in the form of sinking carbon.

III.B.2. Fish Resources

The Alaskan Chukchi and western Beaufort seas support at least 98 fish species representing 23 families (Mecklenburg, Mecklenburg, and Thorsteinson, 2002; Fautin et al., 2010). The primary assemblages of Arctic fishes are defined as (1) freshwater fishes, (2) marine fishes, and (3) diadromous fishes. These assemblages can be further defined at a secondary assemblage level: (a) the neritic-demersal assemblage, (b) the neritic-pelagic assemblage, (c) the cryopelagic fish assemblage, (d) the oceanic-pelagic assemblage, (e) the oceanic-demersal assemblage, and (f) the diadromous assemblage.

Neritic-demersal Assemblage

The neritic-demersal assemblage is comprised of marine fishes living at or near the seafloor of the continental shelf and capable of active swimming. Species of this assemblage that are attributed as being widespread or abundant include the fourhorn sculpin, twohorn sculpin, polar eelpout, and Arctic flounder.

Neritic-pelagic Assemblage

The neritic-pelagic assemblage is comprised of fishes inhabiting the water column over the continental shelf. Species of this assemblage regarded as widespread or abundant include the Pacific herring, Arctic cod, capelin, and Pacific sand lance.

Cryopelagic Assemblage

The cryopelagic fish assemblage describes fishes actively swimming in neritic or oceanic waters but, during their life cycle, are associated with drifting or fast ice. The Arctic cod is abundant in the region and their enormous autumn-winter pre-spawning swarms are well known. The species is also 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.

Oceanic-pelagic Assemblage

The oceanic-pelagic assemblage of fishes inhabits the water column of oceanic waters seaward of the 200-m isobath; most species exhibit some preference for bathymetric stratification. Those species chiefly occurring within the upper 200 m of the water column are regarded as epipelagic fishes. Several of the epipelagic species include the Pacific herring, Arctic cod, polar cod, and Pacific sand lance.

Oceanic-demersal Assemblage

The oceanic-demersal assemblage includes fishes living on or close to ocean-bottom substrates. The ogac, ribbed sculpin, spatulate sculpin, shorthorn sculpin, spinyhook sculpin, archer eelpout, pale eelpout, and daubed shanny are included in this assemblage.

Diadromous Assemblage

The diadromous assemblage fishes move between fresh, brackish, and/or marine waters. The term diadromous incorporates all migration types between marine and fresh waters, including single lifetime events, repetitive multiyear events, spawning migrations, feeding migrations, and seasonal movements between environments.

Nearshore waters are the prime feeding area for North Slope diadromous fishes (Gallaway and Fechhelm, 2000). Diadromous and marine fishes are believed to compete for the same prey resources in nearshore waters (Craig, 1984; Fechhelm, Buck, and Link, 2006).

Of the five species of Pacific salmon (anadromous fishes) present in Alaska, two are regularly present within the action area: pink and chum. The regular 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 Salonius, 1973). Pink salmon are the most abundant salmon species in the Chukchi Sea. There are indications of small runs of chinook salmon in the Kugrua River, through Elson Lagoon (George, pers. comm. cited in Fechhelm and Griffiths, 2001), and strays have been captured in the Kuk River, near Wainwright (Craig and Halderson, 1986).

New information for SEIS analysis

Norcross et al. (2010) established baseline information on demersal fish species and ichthyoplankton in the Chukchi Sea in the U.S. and Russian waters during the summer of 2004. Thirty species within 10 families were collected. Sculpins were the most commonly caught fish. Demersel fish habitat was found to be characterized by sediment type, bottom salinity, and bottom temperature. Twenty-five species of ichthyoplankton were collected in the study. Ichthyoplankton habitat was characterized by water column temperature and salinity. Four fish assemblages were identified based on water mass and habitat characteristics: Coastal Fishes, South Central Chukchi Sea Fishes, Western Chukchi Sea Fishes, and North Central Chukchi Sea fishes. Mecklenburg et al. (2007, 2011) furthered the understanding of fish taxonomy and distribution in the Chukchi Sea.

III.B.3. Essential Fish Habitat

Salmon EFH

Freshwater Essential Fish Habitat (EFH) for salmon includes all streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon. Marine EFH for the salmon 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). In the deeper waters of the continental slope and ocean basin, salmon occupy the upper water column.

New information for SEIS analysis

The Northern Pacific Fisheries Management Council (NPFMC) Arctic Fishery Management Plan (AFMP) (2009) identifies three commercial target species in the U.S. Arctic: Arctic cod, saffron cod, and snow crab (opilio crab). The EFH for these three species was designated as Level 1 EFH (least available information of 4 levels), where distribution data are available for some or all portions of the geographic range of the species. The EFH for the three commercial target species are described as follows (NPFMC, 2009):

Arctic Cod EFH, Adult and Late Juvenile

The general distribution areas for this life stage are located in pelagic and epipelagic waters from nearshore to offshore areas along the entire shelf (0–200 m) and upper slope (200–500 m) throughout Arctic waters, and often associated with ice floes which may occur in deeper waters. The NPFMC has not determined EFH for eggs, larvae, and early juveniles (NPFMC, 2009).

Saffron Cod EFH, Adult and Late Juvenile

The general distribution area for this life stage is located in pelagic and epipelagic waters along the coastline, within nearshore bays, under ice along the inner (0–50 m) shelf throughout Arctic waters, and wherever there are substrates consisting of sand and gravel. The NPFMC has not determined EFH for eggs, larvae, and early juveniles (NPFMC, 2009).

Opilio Crab EFH, Adult and Late Juvenile

The general distribution area for this life stage is located in bottom habitats along the inner (0–50 m) and middle (50–100 m) shelf in Arctic waters south of Cape Lisburne, wherever there are substrates consisting mainly of mud. Essential Fish Habitat for snow crab eggs is inferred from the general distribution of egg-bearing female crabs. The NPFMC has not determined EFH for larvae and early juveniles (NPFMC, 2009).

Ecosystem Component Species

The AFMP describes and maps eight ecosystem component species that “are thought to be, should conditions allow, commercially viable.” These ecosystem component species are yellowfin sole, Alaska plaice, flathead sole, Bering flounder, starry flounder, capelin, rainbow smelt, and blue king crab. Habitat descriptions for these ecosystem component species can be found in the AFMP (NPFMC, 2009).

The Magnuson-Stevens Fishery Conservation and Management Act (as amended) provides for an ecosystem-based approach to the management and protection of fish and fish habitat. Ecosystem component species are a category of non-target species that a Fishery Management Council may consider designating in a Fishery Management Plan. The intent of designating ecosystem component species is to understand the habitat of ecosystem component species, promote ecosystem-based management and provide sound conservation and sustainability of fish and fisheries. The policy of designating ecosystem component species recognizes the "complex interactions among ecosystem components, and seeks to protect important species utilized by other ecosystem component species, potential target species, other organisms such as marine mammals and birds, and local residents and communities" (NPFMC, 2009).

III.B.4. Threatened and Endangered Species

This section provides information on species currently listed as Threatened or Endangered under the Endangered Species Act (ESA) that may be present in the action area. This group includes several marine mammals, specifically bowhead whale, fin whale, humpback whale, and polar bear. Also listed are two species of birds, the spectacled eider and Steller's eider. Kittlitz's murrelet, classified as a candidate species under the ESA, is also considered here.

Marine Mammals (Threatened and Endangered)

Cetaceans

Three species of cetaceans listed as endangered under the ESA occur within or near the Chukchi Sea Planning Area. These species are the bowhead whale, fin whale, and humpback whale. The bowhead whale is the most common ESA-listed whale in the Chukchi Sea. No critical habitat for any of these species has been designated within the Chukchi Sea.

The Western Arctic stock of bowhead whales is the most robust of the bowhead populations; this stock of bowhead whales is increasing, resilient to current levels of mortality and other adverse effects, and may have reached the lower limit of the estimate of the population size that existed prior to intensive commercial whaling (e.g., Shelden et al., 2001; IWC, 2004a,b, 2005,a,b; Angliss and Outlaw, 2005).The abundance of the Western Arctic stock in 2001 was estimated by George et al. (2004) to be 10,470 and by Zeh and Punt (2004, cited in Angliss and Outlaw, 2005) as 10,545. Bowhead whales are potentially more vulnerable to pollution and experience multiple pollution events in their lifetime because they are extremely long lived, slow to mature, slow growing, have low reproductive rates and have high survivorship.

Bowhead whales travel mostly parallel and within 40 miles of the Alaskan coast during spring migration (Quakenbush, Small, and Citta, 2010). 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 primary calving grounds during the spring for these whales. One satellite tagged bowhead whale traveled through the southwestern portion of the Lease Sale 193 area during the spring migration (Quakenbush, Citta, and Small et al.., 2010).

Quakenbush, Citta, and Small et al. (2010) and Quakenbush, Small, and Citta (2010) described the movement and behavior of 37 bowhead whales tagged with satellite transmitters. This 5-year study showed use of the Chukchi Sea planning area by tagged whales. The whales tagged were not necessarily representative of the sex ratio, size class, capture site and time of year of the population. Nineteen bowhead whales likely traveled through some portion of the Lease Sale 193 Area during fall migration. Of these, fourteen transmitted sufficient locations to determine how they passed through the lease area and five with locations transmitted from within leased blocks. Generally, the probability that bowhead whales would use the lease area during the months examined was low (range from 1% to 31%) with the highest probability of use in September. The temporal pattern was similar for the leased blocks, although the probability of use within those blocks (1% or less) was much lower than that for the lease area as a whole. Movements and behavior from this study indicate the greatest potential for disturbance from industrial activities is near Pt. Barrow in September and October and in the lease area in September.

Polar Bear

There are two polar bear stocks recognized in Alaska: the southern Beaufort Sea stock (SBS) and the Chukchi/Bering Seas stock (CBS). The SBS ranges from the Baillie Islands, Canada west to Point Hope. The CBS ranges from Point Barrow west to the Eastern Siberian Sea. These two populations overlap in the western Beaufort Sea and in the eastern Chukchi Sea from Point Hope to Point Barrow, centered near Point Lay (Amstrup, 1995; Amstrup et al., 2005).

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). The coast, barrier islands, and shorefast ice edge provide an important corridor for polar bears traveling and feeding during fall, winter, and spring months. Late winter and spring leads that form offshore from the Chukchi Sea coast provide important feeding habitat for polar bears. Polar bears usually forage in areas where there are high concentrations of ringed seals, as these are their primary prey (Stirling and McEwan, 1975; Larsen, 1985), although bearded seals, walrus, and beluga whales are also taken (Amstrup and DeMaster, 1988). Polar bears 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).

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). Most dens of the CBS are thought to occur on Wrangel Island. Along the U.S. Chukchi Sea coast, polar bear denning occurs at Cape Lisburne; Cape Beaufort; the barrier islands between Point Lay and Peard Bay; the Kukpowruk, Kuk, and Sinaruruk rivers; Nokotlek Point; Point Belcher; Skull Cliff; and Wainwright Inlet.

Polar bears are excellent swimmers and swim while actively hunting, while moving between hunting areas, and while moving between sea ice and terrestrial habitats. 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 bear use of coastal areas during the fall open-water period has increased in recent years and is projected to continue to increase (Kochnev et al., 2003; Schliebe et al., 2005).

Marine and Coastal Birds (Threatened and Endangered)

Threatened and endangered species in the Chukchi Sea Planning Area include the spectacled eider (threatened) and Steller's eider (threatened). These species are known to seasonally occur in the Chukchi Sea OCS. The Kittlitz's murrelet is a candidate species for listing under the ESA.

Full descriptions of each species are provided in the 2006 BE (USDOI, MMS, 2006a), which is hereby incorporated by reference. Summary descriptions are provided below. Full descriptions of each species is also provided in the 2009 BE (USDOI, MMS, 2009b) and BO (USDOI, FWS, 2009). The documents are on the BOEMRE website http://alaska.boemre.gov/ref/Biological_opinions_evaluations.htm.

Spectacled Eider

Spectacled eider was listed as a threatened species under the ESA in May 1993 (58 *FR* 27474). The breeding population on the North Slope currently is the largest breeding population of spectacled eiders in North America. The North Slope population in the fall (October) is estimated to be 33,587 birds (Stehn et al., 2006). Spectacled eider density varies across the Alaskan Arctic Coastal Plain (ACP) (Larned, Stehn, and Platte, 2006).

Spectacled eiders make use of the spring lead system when they migrate from the wintering area. The spring lead system includes the Ledyard Bay Critical Habitat Unit and typically has represented the only open-water area along their path.

Spectacled eiders on the North Slope breed across the ACP, east to approximately the Canadian border. Once tundra nesting habitats are sufficiently melted to allow nesting (historically around June 10), most breeding pairs of spectacled eiders leave nearshore coastal areas to begin nesting on the ACP—as many as a few thousand pairs might nest on the North Slope. Spectacled eider nesting density on the ACP is variable, ranging from 0 to 0.95 nests per square kilometer (Larned, Stehn, and Platte, 2006).

Male spectacled eiders leave the nesting area at the onset of incubation and seek open waters of the Chukchi and Beaufort Seas until they move to molting areas in the Chukchi Sea or Russia. Many postbreeding male spectacled eiders slowly begin to converge in offshore aggregations in Ledyard Bay starting in July and begin an extended molt. While molting they are flightless for several weeks. Males that breed on the ACP (but return to molting areas in Russia) still make limited use of Ledyard Bay and other coastal areas of the Beaufort or Chukchi seas on their westward migration.

Female spectacled eiders begin to move to coastal areas at the end of their nesting effort. Females whose nests fail early on go to the coast and may linger in nearshore areas. Female spectacled eiders also use Ledyard Bay for flightless molt and are flightless for a period of a few weeks. Spectacled eider females with broods are the last to arrive at Ledyard Bay around the end of the first week of September.

The Ledyard Bay area was designated critical habitat for the spectacled eider in 2001 (66 *FR* 9145). The critical habitat area includes the waters of Ledyard Bay within about 74 km (40 nmi) from shore, excluding waters <1.85 km (~1 nmi) from shore. Ledyard Bay Critical Habitat Unit (LBCHU) is an important molting area for North Slope-breeding spectacled eiders in the summer (males) and fall (breeding females). The molt is an energetically demanding period, and eiders are believed to use LBCHU for molting because of a combination of environmental conditions, abundance and accessibility of prey organisms, and level of disturbance and predation. Using satellite telemetry, Petersen, Larned, and Douglas (1999) determined that most spectacled eiders molting at LBCHU were between 30 and 40 km (10–21 nmi) offshore. Overall, many spectacled eiders remain in LBCHU until forced out by sea ice (typically late October through mid-November). Following the molt, spectacled eiders move to their wintering area south of St. Lawrence Island in the Bering Sea.

Steller's Eider

The Alaska breeding population of Steller's eiders is listed as a threatened species under the ESA. It is the least-abundant eider in Alaska, with a discontinuous historic breeding range along the coast from the Alaska Peninsula northward to the Beaufort Sea (Cooke, 1906; Rothe and Arthur, 1994; USDOI, FWS, 2002c).

Although Steller's eiders may occur at greater densities outside Kasegaluk Lagoon, the total numbers probably are low given the small numbers that breed on the North Slope. Less than 5% of the breeding population nests in Arctic Alaska (Rothe and Arthur, 1994). Over 95% of the Alaskan breeding Steller's eiders occur on the ACP near Barrow (USDOI, FWS 1999, 2002b; Quakenbush et al., 2004). The FWS believes the ACP nesting population numbers to be in the hundreds or low thousands. Steller's eiders are paired within flocks when they arrive on the ACP, typically from early to mid-June (Quakenbush et al., 2004). They often nest on coastal wetland tundra, but some nest near shallow ponds or lakes well inland (Bent 1987, Quakenbush et al., 1995, Solovieva 1997); the greatest breeding densities were found near Barrow (Quakenbush, Citta, and Small et al., 2002), although they do not breed every year when present (Suydam, 1997). The calculated average nesting density across the North Slope during 2002–2006 was 0.0045 birds/km^2 (USDOI, FWS, 2007).

Paired male Steller's eiders depart the North Slope after the nest is initiated in mid- to late June. Female eiders and their young-of-the-year typically depart the North Slope from late September to early October (Johnson and Herter, 1989). Unlike spectacled eiders, Steller's eiders do not molt in the Chukchi Sea. During molt migration, Alaskan breeding Steller's eiders stop and rest in areas of the Alaska Chukchi Sea, often in nearshore waters (within 2 km or 1 nmi of shore) near Ledyard Bay and Icy Cape. There is less use at more northerly locations near Wainwright and Peard Bay. More males than females migrate from Alaska to areas along the coast of Chukotka, while males that do not go to Chukotka spend more time on the Alaska Chukchi Sea coast.

Kittlitz's Murrelet

Kittlitz's Murrelet is listed as a candidate species (Listing Priority Number 2) throughout Alaska under the ESA. This species may nest as far north as Cape Beaufort (100 km northeast of Cape Lisburne) in the Amatusuk Hills. Observations of breeding Kittlitz's murrelets are sparse along the Alaskan Chukchi coast. Thompson, Hines, and Williamson (1966) observed a nest several miles inland on the Lisburne Peninsula northeast of Cape Thompson near Angmakrok Mountain. Breeding farther north is unlikely due to lack of suitable habitat (Day, Kuletz, and Nigro, 1999). These birds are solitary nesters and extensive survey efforts are required to determine local abundance.

Murrelet foraging areas may occur in or near the Chukchi Sea Planning Area. Kittlitz's murrelets have been observed on a regular basis in the Chukchi Sea as far north and east as Point Barrow (Bailey, 1948) and could occur in the Beaufort Sea (USDOI, FWS, 2006a). Regular observations of Kittlitz's murrelets at sea were noted in late summer and early fall by Divoky (1987), but they have not been subsequently observed by others on similar cruises in the Chukchi Sea. This suggests that there is a great deal of annual variation in their occurrence in the Chukchi Sea.

New information for SEIS analysis

Changes in status under the ESA for the yellow-billed loon, Pacific walrus, four subspecies of ringed seals, and two distinct population segments of bearded seals are addressed under the "New Information for SEIS Analysis" headings of Section III.B.5 Marine and Coastal Birds and Section III.B.6 Other Marine Mammals.

Analysts' review identified no new information regarding threatened and endangered marine and coastal birds that would change the analysis or alter the conclusions discussed under environmental consequences in Chapter IV.

The following new information regarding threatened and endangered species is incorporated in the Final SEIS.

Bowhead Whale

In recent years, several notable studies on bowhead whales, their abundance, and their use of the Chukchi Sea have become available. The size of the Western Arctic, or Bering-Chukchi-Beaufort (BCB), population appears to remain robust. Koski et al. (2008) provide a preliminary estimate of 11,836 (CV+0.29 and at 95% Confidence Interval 6,795-20,618) for the 2002-2003 population using photo-identification data. Koski et al. (2010) investigated several models using aerial photoidentification data, but the most precise estimate was the result of a simple model with no covariates.

Abundance of the BCB bowhead population in 2004 (excluding calves) was estimated to be 12,631 (CV+0.2442), 95% bootstrap confidence interval (7,900: 19,700) and 5% lower limit of 8,400. All abundance estimates computed from photographic data were consistent with expectations based on independent abundance and trend estimates from the ice-based surveys from 1978 to 2001. There is also more confidence that bowhead whales utilizing the action area are of one stock. Collective results of three decades of research have established that while the BCB population is out of genetic equilibrium, there is no compelling evidence of a multi-stock condition within its range, nor any compelling evidence of conservation risk under the current single-stock management regime (George et al., 2007, Taylor et al., 2007, and IWC, 2008). Rugh et al. (2008) further indicate through spring migration re-identification of individual whales a wide mixing and near-random distribution of resighting dates throughout the spring migration that is indicative of a single stock of whales that have a somewhat plastic schedule.

Ashjian et al. (2010) identified climate and oceanographic mechanisms in the eastern portion of the Chukchi Sea and the western Beaufort Sea northeast of Barrow that form recurrent aggregations of zooplankton and subsequently fall bowhead whale feeding concentrations. Moore et al. (2010) and Moore, Stafford and Munger (2010) note studies that further support late summer and fall feeding concentrations of bowhead whales in that area as per acoustic surveys and visual surveys. Okkenon et al. (2009) provides additional acoustic Doppler current profiler data that infer upwelling and zooplankton aggregation in the western Beaufort shelf in this same area.

Passive acoustic surveys (Delarue et al., 2009) and satellite telemetry studies (Quakenbush et al., 2010; Quakenbush, Small, and Citta, 2010) provide additional data defining spring and late fall-early winter migration routes. Quakenbush et al. (2010) and Quakenbush, Small, and Citta (2010) indicated that all satellite tagged whales travelled through the Lease Sale 193 area, most taking less than one week to transit through. These studies generally confirm what was known about bowhead whale migratory habits, but that corridors are poorly defined and highly subject to interannual variability. Bowhead whales in the Chukchi Sea are subject to a regulated subsistence harvest by Alaska and Russian Natives. A harvest report is submitted to the IWC annually (Suydam et al., 2006, 2007, 2008, and 2009).

During mid-March to approximately mid-June, bowhead whales migrate through leads on their way to their primary summer feeding grounds in the Canadian Beaufort Sea, although Quakenbush, Small, and Citta (2010) noted the Beaufort Sea was virtually 100% ice covered, but that there must be enough openings and thin ice to allow whales to travel straight from Barrow to Amundsen Gulf without lingering and waiting for leads to open. Quakenbush, Small, and Citta (2010) also suggested that land-fast ice does seem to limit the distribution of bowhead whales because in the spring of 2009, six bowhead whales migrated to Amundsen Gulf, which was filled with land-fast ice, and the whales remained at the ice edge until the gulf cleared of land-fast ice.

In many years, large numbers of bowhead whales have been observed feeding in the western Beaufort Sea (Quakenbush et al., 2010). In some years, the northeastern Chukchi Sea is a foraging area for bowhead whales.

Clark and Ferguson (2010) note in 2009, a light ice year, bowhead whales were observed feeding from 30 June to 11 July near Pt. Franklin, and at least one easily identified whale was present during this thirteen day period. Ice cover at this time ranged from 5% to 80%. A group of at least 12 bowhead whales was also observed feeding southwest of Pt. Barrow on 19 September 2009, when no ice was present.

Quakenbush et al. (2010) and Quakenbush, Small, and Citta (2010) described the movement and behavior of 37 bowhead whales tagged with satellite transmitters; tracks for 26 individuals are illustrated in Figure 8 (below). This 5-year study showed use of the Chukchi Sea planning area by tagged whales. The whales tagged were not necessarily representative of the sex ratio, size class, capture site and time of year of the population. Nineteen bowhead whales likely traveled through some portion of the Lease Sale 193 Area during fall migration. Of these, fourteen transmitted sufficient locations to determine how they passed through the lease area. Generally, the probability that bowhead whales would use the lease area during the months examined was low (range from 1% to 31%) with the highest probability of use in September. The temporal pattern was similar for the leased blocks, although the probability of use within those blocks (1% or less) was much lower than that for the lease area as a whole. Movements and behavior from this study indicate the greatest potential for disturbance from industrial activities is near Pt. Barrow in September and October and in the lease area in September. Bowhead whales travel mostly parallel and within 40 miles of the

Alaskan coast during spring migration (Quakenbush, Small, and Citta, 2010). 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 primary calving grounds during the spring for these whales.

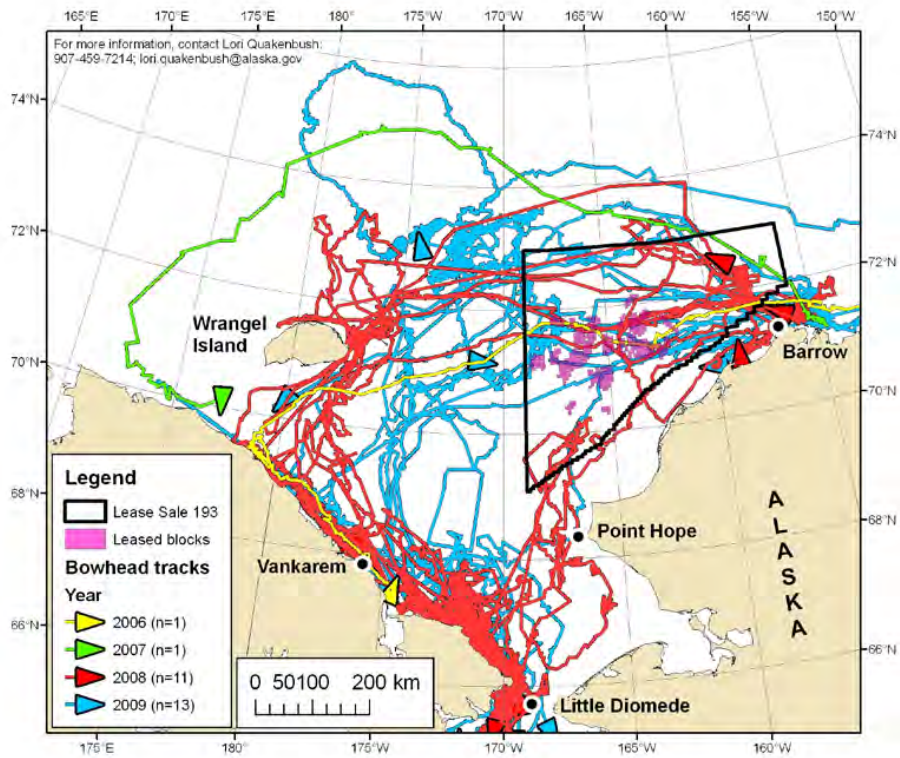

Figure 8. Track of 26 satellite-tagged bowhead whales during fall 2006–2009. (Source: Quakenbush, Small, and Citta, 2010).

Fin and Humpback Whales

During 2006–2009 open-water seasons, marine mammal observer (MMO)-monitoring associated with seismic surveys, barging, and marine research in the Chukchi Sea documented sightings of fin whales and humpback whales.

In the 2008 BO (NMFS, 2008), NMFS found that "there is no indication that fin whales typically occur within the Chukchi Sea or Beaufort Sea Planning Areas or in areas directly adjacent. Fin whales are uncommon to the eastern Chukchi Sea and the Chukchi OCS Planning Area in which lease sales are held."

The 2008 BO by NMFS states that for the purpose of analysis, humpbacks are assumed to occur seasonally just south of the Bering Straight, and that these whales are the source of those observed in the U.S. Beaufort and Chukchi Seas in 2006-2009. The 2006-2009 sightings confirmed humpback use of the western Beaufort Sea and Chukchi Sea Planning Areas, and adjacent areas in the southeast Chukchi Sea. The humpback whales recently sighted in the Chukchi Sea and Beaufort Sea most likely belong to the Western North Pacific Stock. The humpback whale's known summer feeding habitats include the southern portion, especially the southwestern portion, of the Chukchi Sea.

This new information resulted in reinitiation of ESA consultation with NMFS for OCS activities in the Chukchi Sea and Beaufort Sea Planning Areas. The 2008 Biological Evaluation (USDOI, MMS, 2008b) and the 2008 Biological Opinion (NMFS, 2008) provide additional information on these sightings. These documents are on the BOEMRE website http://alaska.boemre.gov/ref/ Biological_opinions_evaluations.htm.

Polar Bear

On May 15, 2008, FWS listed the polar bear as threatened throughout its range (73 FR 28212). The FWS concurrently published an Interim Final 4(d) Rule, which provides guidance on the implementation of the ESA. This special rule adopts the existing conservation regulatory requirements in place under the Marine Mammal Protection Act of 1972 as amended (MMPA) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) as the appropriate regulatory provisions for this threatened species.

The most recent estimate of the Chukchi/Bering Seas (CBS) population of polar bears suggests a minimum of 2000 bears (74 FR 69139 [July 1, 2009]). However this figure is based on older den survey data from Wrangel Island, rather than range-wide mark/ recapture or other population survey methods. The most recent estimate for the Southern Beaufort Sea population of polar bears is a minimum of 1397 bears (74 FR 69139 [July 1, 2009]). The polar bear was listed as a threatened throughout its range largely due to the continuing loss of sea ice habitat caused by climate change (73 FR 28212 [May 15, 2008]). With a small population of a species that has low reproductive rates, any loss of large numbers of polar bears (especially adult females) or prey species would exacerbate that decline. The USGS has predicted that without changes in the rate of sea ice loss, the polar bear will be extirpated from Alaska (Durner et al, 2007). Recovery of the CBS and SBS stocks in Alaska would not occur unless the population begins to rebound from other factors limiting population productivity and growth.

BOEMRE reinitiated ESA Section 7 consultation with FWS in 2009. This consultation addressed the new information on listing the polar bear as threatened, and updated information on ESA listed species, potential effects, and the Arctic environment. In July 2009, BOEMRE provided an updated Biological Evaluation to FWS for consultation on the polar bear (in addition to Steller’s eider, spectacled eider, Kittlitz’s murrelet, yellow-billed loon). The FWS provided their Biological Opinion to BOEMRE on September 3, 2009 (USDOI, FWS, 2009).

On October 29, 2009, FWS published a proposed rule in the *Federal Register* identifying proposed Critical Habitat for the Polar Bear (74 FR 56058). On December 7, 2010, FWS published the final rule designating Critical Habitat in the *Federal Register* (75 FR 76086). The final rule identifies geographic areas containing features considered essential for the conservation of the polar bear. The FWS has identified three areas or units as Critical Habitat that require special management or protection: barrier island habitat, sea ice habitat and terrestrial denning habitat. In the Chukchi Sea, Critical Habitat for the polar bear includes all barrier islands along the coast and sea ice out to the 300m (984 ft) depth extending to the outer limits of the U.S. Exclusive Economic Zone (75 *FR* 76121). BOEMRE ESA consultation with FWS on polar bear critical habitat is in Chapter VI.

Potential impacts to polar bears and their Critical Habitat are analyzed in the “Threatened and Endangered Marine Mammals” section of Chapter IV.

III.B.5. Marine and Coastal Birds

Most birds occurring in the Chukchi Sea area are present on a seasonal basis. During spring migration, arrival times at coastal breeding areas usually coincide with the formation of leads. 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 must migrate through the Sale 193 area twice each year. 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. The following sections summarize movement patterns, locations, and life history characteristics for several key avian groups.

Cliff-Nesting Seabirds

Common murres and thick-billed murres

Common murres and thick-billed murres breed as far north as Cape Lisburne and farther south at Cape Thompson. If the colony is reduced in size below a certain threshold, the colony is abandoned and can remain so for decades. Murres are primarily piscivorous and rely on dispersed schools of offshore fish. Based on limited data, murre foraging areas overlap with the area considered in the proposed sale (Sale 193 FEIS, Fig. III.B-7). Also, as a result of molting and foraging in late summer and fall, flightless males and young are vulnerable to disturbances and spills. Flightless individuals are not capable of undertaking large scale movements to other areas.

Horned puffin and tufted puffin

The horned puffin and the tufted puffin are found in the Chukchi Sea area, where they breed in colonies. Sowls, Hatch, and Lensink (1978) reported the horned puffin was the most abundant puffin species in the Chukchi Sea with breeding colonies at Cape Lisburne and Cape Thompson. They can breed on suitable beach habitat on islands nearshore by digging burrows or hiding under large pieces of driftwood or debris. Horned puffins are primarily piscivorous and rely on dispersed schools of offshore fish. Horned puffins have been reported to forage in excess of 100 km offshore of breeding colonies (Hatch et al., 2000).

Black-legged kittiwake

Breeding colonies of the black-legged kittiwake 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 (USDOI, FWS, 2005a). Divoky (1987) reported black-legged kittiwakes were abundant from mid-July until late September in the Chukchi Sea north of Cape Thompson, where they range far offshore 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 substantial late in the open-water season.

Bering Sea Breeders and Summer Residents

Northern fulmar

The northern fulmar does 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.

Short-tailed shearwater

The short-tailed shearwater in the Chukchi Sea are most common in the southern portion, and are routinely found in the proposed sale area from late August to late September. At northern latitudes, short-tailed shearwaters likely forage on dense patches of euphausiids and amphipods.

Auklets

Three species of auklets, (parakeet, least, and crested) 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.

High Arctic-Associated Seabirds

Black guillemot

Black guillemot breeding individuals in the Chukchi Sea range from Cape Thompson northward (Roseneau and Herter, 1984). Despite the relatively small breeding population in Alaska (the Chukchi and Beaufort seas have a combined total of fewer than 2,000 nesting birds), the post-breeding population of guillemots from the U.S. and Russia is estimated to be around 70,000 in pelagic areas of the Chukchi Sea (Divoky, 1987). Black guillemots remain closely associated with sea ice throughout their lifetime, where they feed extensively on Arctic cod (Divoky, 1987).

Ross' gull

Ross' gulls may be encountered near Point Barrow. Many migrate south through the Chukchi Sea in the late fall and pass through the Bering Strait to winter in the Bering Sea.

Ivory gull

The ivory gull is uncommon to rare in pelagic waters of the Chukchi Sea during summer, and small numbers migrate through in fall to wintering areas in the northern Bering Sea. Divoky (1987) reported that ivory gulls are closely associated with the ice edge throughout their lifecycle.

Arctic tern

The Arctic terns are rare in the pelagic waters of the Chukchi Sea (Divoky, 1983). Dau and Larned (2005) observed more than 600 Arctic terns between Omalik Lagoon and Point Barrow, with the majority located in Kasegaluk Lagoon near the village of Point Lay.

Tundra-Breeding Migrants

Jaegers

The three species of jaegers (pomarine, parasitic, and long-tailed) are common in the Chukchi Sea in summer until late September, when they move south to the Bering Sea (Divoky 1987). Jaegers are dispersed throughout pelagic areas of the Chukchi Sea, with no obvious high concentration areas.

Glaucous gull

Glaucous gulls typically occur in low densities in the Chukchi Sea, but commonly congregate at food sources (Divoky, 1987). They are most common in the Chukchi Sea from late July to late September within 70 km of shore between Icy Cape and Barrow. Most glaucous gulls in the Chukchi Sea area breed inland near freshwater, but some breed at coastal seabird colonies (Divoky, 1987; Sowls, Hatch, and Lensink, 1978).

Waterfowl

Loons

Pacific loons are the most common loon species migrating along the Chukchi Sea coast, although red-throated and yellow-billed loons are present in fewer numbers. 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). Red-throated loons nest on smaller ponds than yellow-billed or Pacific loons. In spring, loons typically migrate along coastal routes, although some may migrate using inland routes (Johnson and Herter, 1989). Most loons stay very close to shore during fall migration until they reach the Lisburne Peninsula, where they head farther out to sea towards the Bering Strait (Divoky 1987). Most of the postbreeding loon migration takes place in September. 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, widely distributed, and able to exploit a greater diversity of habitats (Hunter, 1996).

Long-tailed duck

The long-tailed duck 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 along the 20-m isobath. Many long-tailed ducks molt in Kasegaluk Lagoon and Peard Bay on the Chukchi Sea coast (Johnson, Frost, and Lowry, 1992; Kinney, 1985). 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).

Common eider

The common eider typically migrates during spring along the Chukchi Sea coast using offshore open-water leads. Common eiders nest on barrier islands or spits along the Chukchi Sea coast (Johnson and Herter, 1989). Most 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 eiders were observed 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; by July and August, most common eiders in the Chukchi Sea are molting males. Most breeding female common eiders and their young begin to migrate to molt locations in late August and September. 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 eiders move offshore into pelagic waters, but most eiders remain close to shore (Divoky, 1987).

King eider

Most king eiders begin to migrate through the Chukchi Sea during spring and arrive in the Beaufort Sea by the middle of May (Barry, 1968). The location and timing of offshore leads along the Chukchi Sea is a major factor determining routes and timing of king eider migration (Barry, 1968). Powell et al. (2005) reported that Ledyard Bay may be a critical stopover area for foraging and resting during spring migration. 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). The Peard Bay area is also particularly important to molting eiders (Kinney, 1985), and the typical staging time in Ledyard Bay was reported at 17–24 days (range 1–48 days). Most king eiders nest on the North Slope between Icy Cape and the western boundary of the Arctic National Wildlife Refuge.

Brant

Many brant migrate along the west coast of Alaska en route to breeding areas on the North Slope or the Canadian High Arctic. Brant typically nest on offshore spits, barrier islands, or on islands formed in large river deltas. In June, black brant have been observed along the Chukchi Sea coast in Kasegaluk Lagoon and Peard Bay (Dau and Larned, 2005). Kasegaluk Lagoon also is an important stopover location during postbreeding migration.

Greater white-fronted goose

The greater white-fronted goose 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 (King, 1970 cited in Johnson and Herter, 1989). 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). In 1989–91, 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.

Lesser Snow Goose

There are very few lesser snow geese (*Chen caerulescens caerulescens*) 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, one of two consistently used nesting colonies for lesser snow geese.

Tundra swans

Tundra swans have been observed in Kasegaluk Lagoon with flightless young-of-the-year birds indicating that tundra swans breed in Kasegaluk Lagoon (Johnson, Wiggins, and Wainwright, 1992).

Shorebirds

Although many shorebirds breed on tundra, they also 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, semipalmated sandpiper, pectoral sandpiper, and red phalarope (Alaska Shorebird Working Group, 2004). Many shorebirds leaving the Beaufort Sea move west along the Chukchi Sea coast. 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.

Phalaropes

Both red and red-necked phalaropes 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 and variable; however, because they are tied to a moving prey source they may be encountered throughout the Chukchi Sea in varying concentrations. During aerial surveys conducted in Kasegaluk Lagoon from 1989–91, phalaropes were the most numerous shorebirds present. 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 most abundant species groups of shorebirds that use Kasegaluk Lagoon and Peard Bay, where they stage or stop over in nearshore marine and lacustrine waters (Alaska Shorebird Working Group, 2004).

Dunlin

Two subspecies of Dunlin breed in Alaska. Dunlins are another of the most abundant species of shorebirds that use Kasegaluk Lagoon, where they stage or stop over in silt tidal flats and salt-grass meadows (Alaska Shorebird Working Group, 2004).

Raptors and Ravens

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. Snowy owls are the raptor most commonly encountered near Kasegaluk Lagoon.

New information for SEIS analysis

On March 25, 2009, the yellow-billed loon was recognized as a candidate species (Listing Priority Number 8) throughout its range under the ESA (74 FR 12932).

BOEMRE reinitiated ESA Section 7 consultation with FWS in 2009. This consultation addressed the new information on recognizing the yellow-billed loon as a candidate species and updated information on ESA listed species, potential effects, and the Arctic environment. In July 2009, BOEMRE provided an updated Biological Evaluation to FWS for consultation on Steller’s eider, spectacled eider, Kittlitz’s murrelet, yellow-billed loon, and polar bear. The FWS provided their Biological Opinion to BOEMRE on September 3, 2009 (USDOI, FWS, 2009).

III.B.6. Other Marine Mammals

Eleven species of marine mammals occur in the Chukchi Sea and are not currently listed as endangered or threatened under the ESA.

Pinnipeds

Five species of pinnipeds are associated with sea ice in Alaskan waters: Pacific walrus and four species of phocid seals or ice seals (ringed, spotted, ribbon, bearded). All five species haul out on sea ice to rest, give birth, and molt, and they all exhibit 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 (Fay, 1974; Burns, Shapiro, and Fay, 1981; Simpkins et al., 2003).

Pacific walrus

Pacific walrus 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. Walrus are migratory, moving south with the advancing ice in autumn, and north as the ice recedes in spring (Fay, 1981). During the summer months, the majority of the subadults, females, and calves move into the Chukchi Sea, where they tend to concentrate in areas of unconsolidated pack ice within 100 km of the leading edge of the pack ice. In contrast, adult males generally abandon the sea ice in spring for coastal haulouts in Bristol Bay and the Gulf of Anadyr (Jay and Hills, 2005). 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. Walrus 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 (Fay, 1982). 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, Icy Cape, and the barrier islands off of Kasegaluk Lagoon. In low ice years, when the pack ice retreats northward of the continental shelf, walrus come ashore to rest and remain near foraging areas. For example, in 2010, as many as 10,000-20,000 walrus were hauled out along the barrier island northwest of Point Lay (USDOI, FWS, 2010). As the pack ice advances at the end of the summer open-water season, large herds begin moving back down to the Bering Sea.

Walrus 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. 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). Walrus specialize in feeding on benthic macroinvertebrates (e.g., clams, snails, shrimp, crabs, worms) and prefer to forage in areas <80 m deep (Fay, 1982).

Ringed Seal

Ringed seals are year-round residents in the Chukchi and Beaufort seas, and are the most common and widespread seal species in the area. In winter and spring, the highest densities of ringed seals are found on stable, shorefast 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). 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). 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). 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). In Alaskan waters, the primary prey of ringed seals is Arctic cod, saffron cod, shrimp, amphipods, and euphausiids (Kelly, 1988; Reeves, Stewart, and Leatherwood, 1992).

Spotted Seal

Spotted seals are common in the coastal Alaskan waters in ice-free seasons, and they often aggregate in onshore coastal haulouts. They migrate south from the Chukchi Sea and into the Bering Sea in October-November (Lowry et al., 1998). 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 saffron cod, 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).

Ribbon Seal

In Alaska, ribbon seals 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). Recent information suggests that many ribbon seals migrate into the Chukchi Sea for the summer months (Kelly, 1988). 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 such as eelpouts, capelin, pricklebacks, Arctic cod, saffron cod, herring, and sand lance. Foods other than fishes include cephalopods (primarily squid), shrimp, mysids, and crabs.

Bearded Seal

In Alaskan waters, bearded seals occur over the continental shelves of the Bering, Chukchi, and Beaufort seas (Burns, 1981). 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. 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. 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. 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).

Cetaceans

Beluga Whale

Beluga whales of the Beaufort Sea and eastern Chukchi Sea 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). 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). 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). 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). Stomach content analysis of belugas suggests 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) and deeper slope waters.

The main fall-migration corridor of beluga whales is ~100+ km north of the coast. 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). It is likely members from both stocks occur in similar places and at similar times during the fall migration (Suydam, Lowry, and Frost, 2005).

Most feeding is done over the continental shelf and in nearshore estuaries and river mouths. 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, shrimp, crabs, and clams are eaten occasionally. 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).

Killer Whale

Killer whales occur along the entire Alaskan coast (Braham and Dahlheim, 1982), including the Chukchi Sea. 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 are observed rarely in the Alaska Arctic. A discussion of these whales is in the Sale 193 FEIS. New information indicates a crude estimate of 56 killer whales off the Chukotka coast (Melinkov, 2007).

Harbor Porpoise

In Alaska, three separate stocks have been recommended; the Bering Sea stock is the only stock expected to be present in the action area. Sixteen Native accounts of harbor porpoise near Point Barrow and along the northern coast of Alaska between 1930 and 1991 are noted in Suydam and George (1992). Harbor porpoises occur mainly in shelf areas (Read, 1999), diving to depths of at least 220 m and staying submerged for more than five 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. Harbor porpoises feed on a variety of small, schooling fish and cephalopods (Read, 1999).

Harbor porpoise are discussed in the Sale 193 FEIS. New information has been found regarding 16 Native accounts of harbor porpoise near Point Barrow between 1930 and 1991 (Suydam and George, 1992).

Gray Whale

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). 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 et al., 1984).

Gray whales are bottom feeders, sucking sediment from the seafloor. Their primary prey is amphipods, although other food items (including polychaete worms, crab larvae, small fish and benthic invertebrates) are also ingested. 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 gray whale feeding area is in the Chukchi Sea southwest of Barrow (Clarke et al., 1989) and they were known to feed in the offshore shoals at least as far north as Hanna Shoal (located near the northern boundary of the Chukchi Sea Planning area). In the time period between 1982 and 1991 gray whales were frequently seen on Hanna Shoal (Moore and Clarke, 1992). Recent aerial surveys (Clarke et al., 2011) have found an apparent shift in distribution, with no gray whales seen in the offshore shoals in 2008, 2009, or 2010. The relative lack of gray whale sightings (and mudplumes that indicate the presence of feeding gray whales offshore) was markedly different from observations made during 1982-1991 surveys. Industry marine mammal observers have observed some whales in the general area immediately southeast of Hanna Shoal each year since 2007. The observation by industry observers of gray whales in the vicinity of leases and Hanna Shoal may indicate some use remains; however, these observations do not indicate feeding, specifically.

Minke Whale

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. Minke whales feed on fish (e.g., herring, sand lance) as well as on invertebrates (e.g., euphasiids, copepods).

New information for SEIS analysis

Bearded and Ringed Seals. On December 6, 2010 NMFS released status reviews for bearded and ringed seals (Cameron et al., 2010; Kelly et al., 2010) in response to petitions to list ringed, bearded, and spotted seals as threatened under the ESA (Center for Biological Diversity, 2008). On December 10, 2010 proposed rules to list ringed and bearded seals were published in the *Federal Register* (75 FR 77496; 75 FR 77496). BOEMRE has reviewed the status reviews and *Federal Register* notices and would initiate ESA consultation if NMFS officially listed either species. In light of the above actions, additional information is provided regarding ice seals populations in the Chukchi Sea and adjacent regions.

Surveys by Brueggeman et al. (2009), Blees et al. (2010), and Funk et al. (2010), provide additional ocular observation data concerning tendencies in the distributions of pinniped species, though the data focuses on very specific locations at very specific times during three open water seasons.

Kelly et al. (2010) estimates that over 1,000,000 ringed seals inhabit the Beaufort, Chukchi and Bering Seas based on information from existing surveys and studies. Ringed seal numbers are believed to be 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 abundance estimate of 252,488 ringed seals in the eastern Chukchi Sea, while Frost and Lowry (1981) estimated 80,000 ringed seals in the Beaufort Sea during summer and 40,000 during winter. Some authors (Armstrup 1995) believe the Beaufort Sea population is four times these numbers. Kelly et al. (2010) placed their maximum density estimate of ringed seals at Prudhoe Bay and along the coast south of Kivalina at 1.62 seals/km^2.

Early estimates of the Bering-Chukchi seas bearded seal population ranged from 250,000-300,000 (Burns 1981; Popov 1976). Cameron et al. (2010) developed a crude estimate of 3,150 resident bearded seals in the Beaufort Sea that was uncorrected for submersed seals or seasonal migrants, and around 27,000 residents in the Chukchi Sea. Cameron et al. (2010) estimated the maximum density of bearded seals from Prudhoe Bay to the coast south of Kivalina to be about 0.14 seals/km^2. No evidence suggests a population decline has occurred and stocks are considered healthy. Whiting and Naylor (2011) submitted a map (Figure 9) of marine mammal usage (including bearded and ringed seals) in the area during the Sale 193 Revised Draft SEIS comment period.

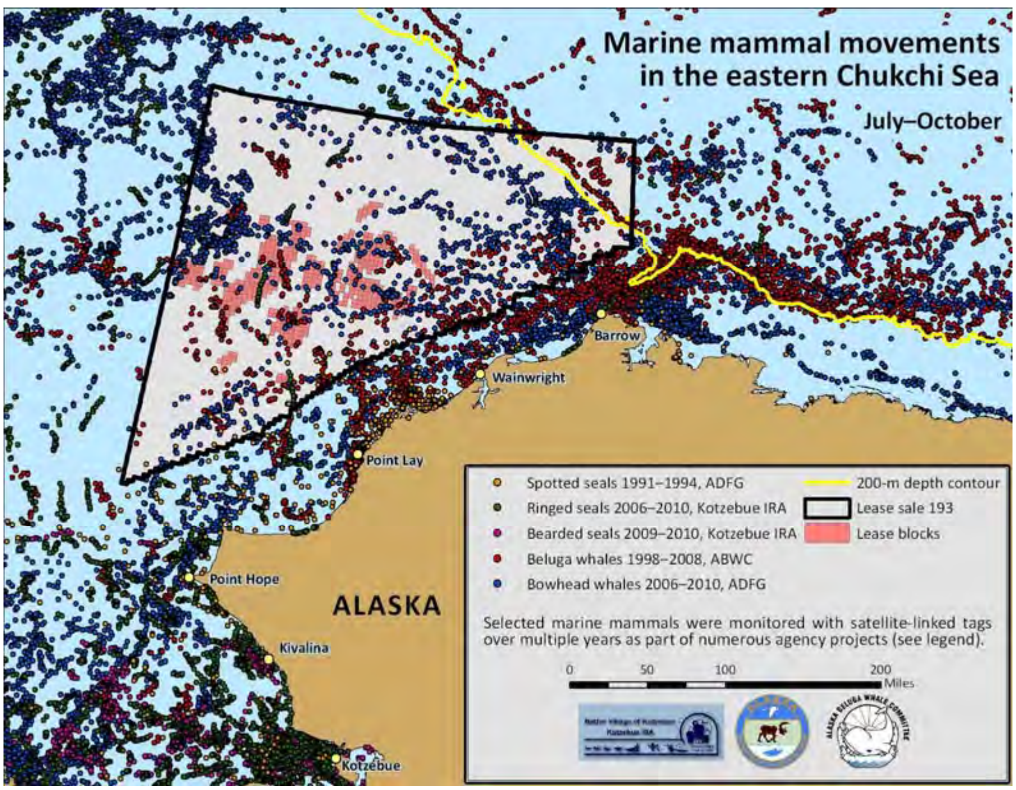

Figure 9. Selected marine mammal location information, including bearded and ringed seals, monitored with satellite-linked tags over multiple years. (Source: Received with comment from Whiting and Naylor, 2011)

Spotted Seals. There have been recent efforts to improve abundance estimates for spotted seals in the Bering Sea (Boveng et al., 2009; Allen and Angliss 2010). Studies to determine a correction factor for the number of spotted seals at sea missed during surveys have been initiated, but only preminary results are currently available. The Alaska Department of Fish and Game placed satellite transmitters on four spotted seals in Kasegaluk Lagoon and estimated the ratio of time hauled out versus time at sea. Preliminary results indicate the proportion of spotted seals hauled out are on average about 6.8%

(CV = 0.85) (Lowry et al., 1994). Using this correction factor, with the maximum count of 4,145 from 1992, results in an estimate of 59,214 spotted seals in Alaskan waters (Allen and Angliss 2010). Unstratified density estimates of spotted seals in the southeastern Bering Sea were calculated to be 0.37 spotted seals per square nautical mile (nmi^2). Abundance estimates for that region were reported as 10,876 (stratified) and 13,125 (unstratified); however, only seals on the ice were counted and no adjustment was made for seals in the water (Allen and Angliss 2010).

Ribbon Seals. There have also been efforts to improve abundance estimates for the Alaska stock of ribbon seals. Burns (1981) estimated the Bering Sea ribbon seal population at 90,000-100,000, and aerial surveys have been conducted in parts of the eastern Berin Sea in 2003 (Simpkins et al., 2003), 2007 (Cameron and Boveng 2007, Moreland et al., 2008), and 2008 (Peter Boveng, NMML, unpubl. data). Data from the aerial surveys are currently being analyzed to construct estimates of abundance for the eastern Bering Sea from frequencies of sightings, ice distribution, and the timing of seal haulout behavior. In the interim, NMML researchers have developed a provisional estimate of 49,000 ribbons seals in the eastern and central Bering Sea during the surveys (Allen and Angliss). Ribbon seal observations remain rare in the Beaufort Sea, but are more common in the Chukchi Sea. In more recent industry-related surveys (Funk et al., 2011; Brueggeman et al., 2009; Blees et al., 2010), very small numbers of ribbon seals were occasionally observed by marine mammals observers. Existing data indicates ribbon seals mostly occur in the northern Bering and southwestern Chukchi seas, with a small scattering of individuals in the eastern and northern Chukchi Sea.

Pacific Walrus. On February 10, 2011, the U.S. Fish and Wildlife Service (FWS) released its 12-month Finding on a Petition to List the Pacific Walrus as Endangered or Threatened. The FWS found that listing the Pacific walrus as threatened throughout its range (Figure 10) is warranted due to

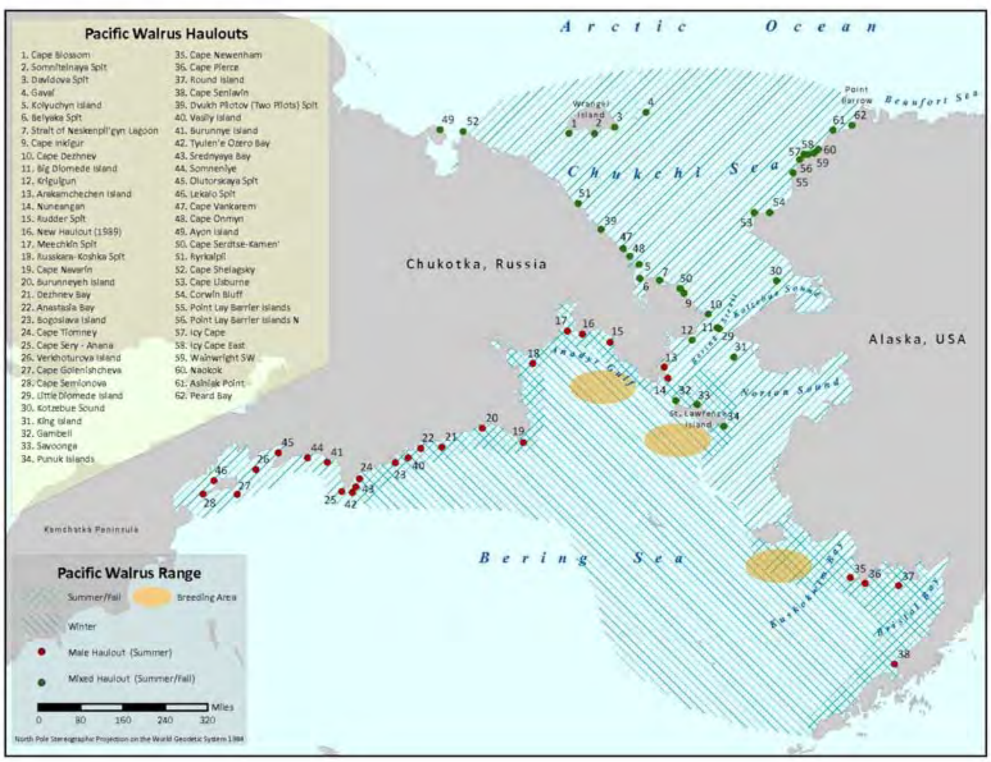

Figure 10. Pacific walrus home range and haulout sites. (Source: Garlich-Miller et al., 2011).

diminishing sea ice, but precluded by higher priority actions to amend the Lists of Endangered and Threatened Wildlife and Plants (76 FR 7634). The most recent estimate for the Pacific walrus population is 129,000 based on a 2006 survey (Speckman et al., 2010).

Killer Whales. Funk et al. (2011) notes Marine Mammal Observer observations of killer whales in the Lease Sale Area in 2006, 2007, and 2008 during open water season oil and gas related operations.

III.B.7. Terrestrial Mammals

Caribou, muskoxen, grizzly bear, and Arctic fox are the terrestrial mammal species most likely to be affected by development and production of natural gas from the Chukchi Sea OCS. Other species, such as moose, are too sparse in the area to be affected by Chukchi Sea development.

Caribou

Three caribou herds use habitats of Alaska's Arctic plain in the project area: the Western Arctic Herd (WAH), the Central Arctic Herd (CAH), and the Teshekpuk Lake Herd (TLH).

Caribou from the CAH and WAH migrate seasonally to take advantage of seasonally available forage resources, however TLH are more sedentary, remaining on their herd range throughout the year. For the CAH and WAH the spring migration of parturient female caribou from the overwintering areas to the calving grounds starts in late March (Hemming, 1971), with bulls and nonparturient females generally migrate later.

Synchronized calving takes place in the spring, generally from late May to late June (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. The WAH calving area is inland on the NPR-A, west of the Proposed Action area. The TLH'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.

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.

Insect-relief areas also become important during late June to mid-August during the insect season (Lawhead, 1997). For insect relief, caribou use various coastal and upland habitats such as ridges, snowfields, mountain foothills, sand dunes, sand bars, spits, river deltas, and barrier islands where strong breezes prevent swarms of biting mosquitos and oestrid flies from plaguing caribou.

Muskoxen

There are muskoxen west of Prudhoe Bay as far as Fish Creek in northern NPR-A and in the Itkillik Hills south of Kuparuk all the way to the Colville River. Distribution of muskoxen during the calving season, summer, and winter are similar (Reynolds, 1992). Family groups may frequently be seen along the Beaufort Coast between Prudhoe Bay and the Colville River. The most important habitats for muskoxen appear to be riparian shrub areas, upland shrub areas and moist sedge-shrub meadows (Johnson et al., 1996).

Grizzly Bear

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). Grizzly bears in the western Brooks Range use a variety of food sources seasonally, including the WAH, beach-cast marine mammal carcasses and, to a small degree, fish runs that occur in major Chukchi coast drainages.

Arctic Fox

The availability of winter food sources directly affects fox abundance and productivity (Angerbjorn et al., 1991). Development at the Prudhoe Bay oil fields probably has led to increases in Arctic fox abundance and productivity (Burgess, 2000) as foxes readily use development sites for feeding, resting, and denning, and their densities are greater in the oil fields than in surrounding undeveloped areas (Eberhardt et al., 1982; Burgess et al., 1993).

New information for SEIS analysis

No new information regarding terrestrial mammals has been introduced in this Final SEIS.

III.B.8. Vegetation and Wetlands

Vegetation

The following paragraphs describe the most common vegetation types found up to 50 km inland from the Chukchi Sea shoreline. The description of vegetation in the study area is based on studies conducted by the Circumpolar Arctic Vegetation Mapping Team (2003).

Sedge, Moss, Dwarf-Shrub Wetlands

These wetlands are the most abundant vegetation type within the 50-km belt and cover about 41% of the area.

Tussock Sedge, Dwarf Shrub, Moss Tundra

This plant community, classified as moist tussock tundra, is the second most abundant within the 50-km belt and covers about 24% of the area.

Sedge/Grass Moss Wetland

This vegetation type covers about 9% of the area within the 50-km belt.

Erect Dwarf-Shrub Tundra

This tundra community covers about 8% of the area within the 50-km belt.

Nontussock Sedge, Dwarf-Shrub, Moss Tundra

This moist tundra plant community covers about 6% of the area evaluated within 50-km belt.

Noncarbonate Mountain Complex

This vegetation type covers about 6% of the area within the 50-km belt, and is found on mountains and plateaus with noncarbonate bedrock.

Carbonate Mountain Complex

This vegetation type covers about 4% of the area within the 50-km belt, and is found on mountains and plateaus with limestone and dolomite bedrock.

Sedge, Moss, Low-Shrub Wetland

This vegetation type covers about 1% of the area within the 50-km belt.

Low-Shrub Tundra

This vegetation type covers about 1% of the area within the 50-km belt.

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. 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.

New information for SEIS analysis

No new information regarding vegetation and wetlands has been introduced in this Final SEIS.

III.C. Social Systems

III.C.1. Economy

Economic activity is measured in the form of revenues, employment, and personal income. Alaska OCS activities contribute to economic activity in the North Slope Borough (NSB), State of Alaska, and Federal government.

The tax base in the NSB consists mainly of high-value property owned or leased by the oil industry in the Prudhoe Bay area. NSB oil and gas property tax revenues have exceeded $180 million annually. In 2005, revenues from oil and gas property taxes were $197 million, and total general fund revenues were $220 million. The State of Alaska’s tax base is comprised mostly of revenues from oil and gas production. Federal revenues are generated primarily from income and payroll taxes.

The NSB is the largest employer of permanent residents in the NSB. However, very few North Slope residents have been employed by the oil and gas industry or supporting industries in and near Prudhoe Bay since production started in the 1970’s. Local residents represent only about one percent of those hired for North Slope oil industry related jobs, with most North Slope oil-industry workers residing outside the NSB. Unemployment in the NSB has ranged from 3.5% to 10.1% between 1975 and 2007. Aggregate personal income for the NSB in 2006 was $0.3 billion.

The oil and gas industry is also extremely important in the State of Alaska generally, accounting for more than 41,000 jobs, 9.4 percent of employment, and 11.2 percent of wages in the state.

New information for SEIS analysis

In 2008, NSB revenues from oil and gas property taxes were $235 million, and total general fund revenues were $281 million. These figures do not represent a significant change from recent past years’ totals, as NSB’s revenues from these sources have remained rather steady.

Unemployment in the NSB has ranged from 3.5% to 5.3% between 1975 and 2010. Aggregate personal income for the NSB in 2008 was $448 million, and per capita personal income was $66,664. Again, this figure is generally consistent with aggregate personal income figures over recent past years.

III.C.2. Subsistence-Harvest Patterns

Generally, subsistence is considered hunting, fishing, and gathering for the primary purpose of acquiring traditional food. The Marine Mammal Protection Act of 1972, as amended, (MMPA) defines subsistence as follows:

> The term “subsistence uses” means the customary and traditional uses by rural Alaska residents of marine mammals for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicrafts articles out of nonedible byproducts of marine mammals taken for personal or family consumption; and for barter, or sharing for personal or family consumption (16 USC 1361).

Subsistence activities are assigned the highest cultural values by the Iñupiat and provide a sense of identity in addition to being an important economic pursuit. The sharing, trading, and bartering of subsistence foods structure relationships among communities, and the sharing of these foods helps maintain ties with family members elsewhere in Alaska. For example, a community member of Point Lay described what the subsistence lifestyle means to her and her family:

> I love going out to the ocean with my husband. We share a lot of good times together out there. Brings us joy to our family when we bring home something from the ocean. And when the captains bring home a whale, it's a happy occasion for the community. It brings the community together stronger, and we are able to work with each other hand in hand. And it's a blessing, the ocean. It brings life to everyone, you know. [Ms. Joanne Neakok, Pt. Lay, Alaska, June 28, 2011).

Many studies have examined the relationship between subsistence and wage economies and how subsistence and wage activities are integrated into rural Alaskan socioeconomic systems. 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 (e.g., to purchase a boat, fuel, guns, and ammunition). Full-time employment, however, limits the time a subsistence hunter can spend hunting to after-work hours.

Community Subsistence-Harvest Patterns

The communities adjacent to the Chukchi Sea Planning Area live within a diverse resource base that includes both marine and terrestrial animals. Generally, communities harvest the resources most available to them. Coastal/marine food resources include whales, seals, walrus, waterfowl, and fish (Figure 11). Terrestrial/aquatic resources include caribou, freshwater fishes, moose, Dall sheep, edible roots and berries, and furbearing animals. The aggregate community subsistence-harvest areas are extensive for the primary subsistence resources, including marine mammals (whales, seals, walrus, polar bears), caribou, fish, birds (and eggs), furbearers (for hunting and trapping), moose, Dall sheep, grizzly bears, small mammals, invertebrates, berries, edible roots, and fuel and structural material. Large portions of the marine subsistence-harvest areas of the Alaskan Chukchi subsistence communities are included in the Chukchi Sea Planning Area.

Figure 11. A Kotzebue community member prepares subsistence foods.

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 cited in Alaska Consultants, Inc., Courtnage, and Braund, 1984). 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. Seal oil from hair seals is an important staple and a necessary complement to other subsistence foods. Another community member of Point Lay offered the following analogy:

> I hear a lot of people saying that the ocean and land is like our garden. I don’t know how many people in the U.S. have gardens anymore. More and more people are used to shopping at … a Safeway. I like to look at it this way: The land is my Safeway, and the ocean is my Sam’s Club. I get all my bulk foods from the ocean, and I get all my canned goods and baked goods from the land. (Mr. William Tracey, Jr., Pt. Lay, Alaska, June 28, 2011)

The subsistence pursuit of bowhead whales is of major importance to the Chukchi Sea coastal communities most likely to be affected by Lease Sale 193: Barrow, Wainwright, Point Hope, and Point Lay (see Figure 1). Barrow’s location at the demarcation point between the Chukchi and Beaufort seas is unique and, until recently, Barrow was the only community adjacent to the Planning Area that harvests whales in the spring and fall. This changed in October of 2010 when Wainwright whaling crews harvested a bowhead whale in the fall (AEWC, 2011). Although Wainwright, Point Hope, and Point Lay have traditionally hunted for bowhead whales only in the spring season (North Slope Borough, 1998), there is reason to consider that fall whale hunts might continue in Wainwright and also occur in Point Hope and Point Lay. Wainwright’s 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 is an important marine and wildlife habitat used by local Wainwright hunters. Point Hope’s strategic location close to the pack-ice lead makes it uniquely situated for hunting the bowhead. Point Lay, about 90 mi southwest of Wainwright, sits on the edge of Kasegaluk Lagoon near the confluence of the Kokolik River with Kasegaluk Lagoon. Beluga whale is the village’s preferred and pivotal marine mammal resource (Huntington and Mymrin, 1996; Huntington, 1999). Point Lay hunters have recently pursued and obtained a bowhead whale quota for the community. Point Lay took one bowhead whale in the spring 2009 hunt.

The Sale 193 FEIS provides information on annual harvests of subsistence resources for the Chukchi Sea communities (see Sale 193 FEIS: Tables III.C-4, III.C-5, III.C-6, III.C-7, III.C-8, and III.C-9). Summaries of the Chukchi Sea coastal communities and maps of each community’s subsistence-harvest areas are included in the Sale 126 FEIS (USDOI, MMS, 1990b). Maps of the subsistence-harvest areas are included also in the Northwest NPR-A FEIS (USDOI, BLM and MMS, 2003).

New information for SEIS analysis

Annual bowhead whale subsistence harvest assessments by Suydam et al. (2006), Suydam et al. (2007), Suydam et al. (2008), Suydam et al. (2009), and Suydam et al. (2010) provided new harvest data in relation to the annual subsistence bowhead whale hunts in Chukchi Sea coastal communities. Two Chukchi Iñupiat communities have recently instituted changes in their subsistence patterns. Point Lay succeeded in securing a quota from the International Whaling Commission for bowhead, and subsequently landed whales during spring. Wainwright initiated fall whaling, which has also been successful. Huntington (1999) and the Communities of Buckland, Elim, Koyuk, Point Law, and Shaktoolik employs TEK to broaden the information record concerning beluga whale migration and behavior in the region. A BOEMRE study under the Coastal Marine Institute at the University of Alaska, Fairbanks documented traditional knowledge regarding bowhead whales in the Chukchi Sea near Wainwright, Alaska (Quakenbush and Huntington, 2010).

III.C.3. Sociocultural Systems

"Sociocultural systems" encompasses three organizing concepts: social organization, cultural values, and institutional organizations of communities. These concepts are interrelated.

Social organization

"Social organization" means how people are divided into social groups and networks. Social organization encompasses households and families, but also wider networks of kinship and friends, which, in turn, are embedded in groups that are responsible for acquiring, distributing, and consuming subsistence resources. The fundamental Iñupiat social organization is kin-related groups engaged in subsistence activities.

Cultural values

"Cultural values" means concepts regarding what is desirable that are widely and explicitly or implicitly shared by members of a social group. The Iñupiat culture on the North Slope has strong ties to the natural environment. Cultural values, many of which are rooted in, maintained, and reinforced by the interrelatedness of social organization, include a close relationship with natural resources and an emphasis on kinship, maintenance of the community, cooperation, and sharing. An anecdote from one Point Hope community member illustrates how culture is passed down to the next generation:

> Last early Monday morning, my ten-year-old son caught his first seal. He dreams about hunting ever since he was a little boy. That's his passion. He goes out whenever he can, hunting mammals, fishing, hunting for caribou, and he wants to continue to do this. We all want our young people to continue hunting all the animals that we are used to surviving on. (Mr. Peggy Frankson, Pt. Hope, Alaska, June 22, 2011).

Subsistence is a central activity that embodies these values, with bowhead whale hunting being the paramount subsistence activity. Family and kinship relationships are strong influences on contemporary life, shaping social interactions that include cooperative activities and sharing. Cultural values of the Iñupiat 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).

Residents of the 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. Cultural concerns mentioned include:

- 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).
- Concern that an influx of population and outside influences will disrupt and degrade Iñupiat community life.
- Concern that oil and gas development will impose additional demands upon Iñupiat communities and individuals such as numerous hearings and review of numerous documents.

Institutional organization

"Institutional organization" refers to the government and nongovernment entities that provide services to the community. Institutional arrangements focus primarily on the structure of borough, village, and tribal governments, and the Native regional and various village for-profit and not-for-profit corporations. But this could include extended institutional arrangements or voluntary organizations such as Search and Rescue. The government and nongovernmental organizations that make up the institutional organization of the area include the NSB, city governments, Tribal governments, Alaska Native Regional Corporations, village corporations, nonprofit corporations, and nongovernmental organizations, such as the Alaska Eskimo Whaling Commission (AEWC).

Each of the Chukchi Sea coastal communities, except Point Lay, has a city government. While certain municipal powers were turned over to the North Slope Borough, community governments play an important role in the administration of NSB programs and representing community interests. Federally recognized tribal governments in most Chukchi Sea Native villages are active in community government and in providing services to tribal members. The NSB provides all utilities to Chukchi Sea coastal communities and subsidizes fuel costs. No roads connect these communities, and 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. Army Corps of Engineers, 2005).

Point Hope, Point Lay, Wainwright, and Barrow have either a traditional village or Indian Reorganization Act Tribal council form of tribal government. The Iñupiat Community of the Arctic Slope, the regional tribal government, has recently taken a more active and visible role in regional governance and in providing some services to tribal members.

The Arctic Slope Regional Corporation (ASRC) runs several subsidiary corporations, and along with village profit and not-for-profit corporations, has provided employment and other services in the Borough's communities. An in-depth profile of the ASRC and Alaska Native village corporations for Atqasuk (Atqasuk Corporation), Point Lay (Cully Corporation), Wainwright (Olgoonik Corporation), Point Hope (Tikigaq), and Barrow (UIkpaegvik Iñupiat Corporation) is 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 and private lands.

Nongovernment organizations, such as the AEWC and whaling captain's associations, play an important role in the management of resources vital to the subsistence and cultural needs of the communities.

New information for SEIS analysis

No new information regarding sociocultural systems has been introduced in this Final SEIS.

III.C.4. Archaeological Resources

There are two major locations for archaeological resources/historic properties in the Sale 193 area: offshore and onshore. Within these locations, archaeological resources/historic properties are identified and discussed as either prehistoric or historic.

Offshore Archaeological Resources

The Chukchi Sea area under consideration in this Final SEIS was once a portion of Beringia, the Bering Land Bridge, across which humans and Pleistocene megafauna migrated from Asia to Alaska and species indigenous to the Americas (such as the horse) migrated to Asia. It is conservatively estimated that prehistoric human populations entered North America by at least12,000 years B.P. (see for example Hopkins, 1967; Bonatto and Salzano, 1997; Wang et al., 2007; and Goebel et al., 2008). BOEMRE uses a conservative date of 13,000 B.P. as the earliest possible human migration and occupation of Alaska in the analysis of prehistoric archaeology potential. BOEMRE has adopted a slightly deeper water depth of -60 m as representing the possible 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.

Any shipwrecks in the Sale 193 area beyond the areas of intensive ice gouging are more likely to be preserved than shipwrecks in State waters because wave action and ice are less likely to contribute to the breakup of ships in deeper waters. Two potential shipwreck locations have been identified in the Sale 193 area (see Map 7 of the Sale 193 FEIS).

Onshore Archaeological Resources

Information for some of the approximately 83 known archaeological sites onshore in the Chukchi Sea coastal area is in the Alaska Heritage Resources Survey File (State of Alaska, DNR, 2006). 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 illustrate the archaeological-resource potential of the shore area along the Chukchi Sea coast. The Chukchi Sea coast is eroding at an average of about 0.3 m per year, periodically exposing new archaeological sites.

New information for SEIS analysis

No new information regarding archaeological resources has been introduced in this Final SEIS.

III.C.5. Environmental Justice

Alaska Iñupiat Natives are residents of the communities of the North Slope, a recognized U.S. minority group, and the predominant residents of the NSB. The ethnic compositions of Barrow, Atqasuk, Wainwright, Point Lay, and Point Hope are shown in Table III.C-15 in the Sale 193 FEIS (USDOI, MMS, 2007a). The table shows that these communities are classed as minority communities on the basis of their proportional American Indian and Alaska Native membership. 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, 2010). Alaska Natives are the only minority population allowed to hunt for marine mammals in the U.S. Chukchi Sea region. There are not substantial numbers of "other minorities" in potentially affected Iñupiat communities. Negative effects to members of these communities could occur because OCS activities may negatively affect the subsistence resources, subsistence harvest practices, and sociocultural systems that members of North Slope communities rely upon.

New information for SEIS analysis

No new information regarding Environmental Justice has been introduced in this Final SEIS.

Chapter IV

Environmental Consequences

CHAPTER IV. Environmental Consequences

IV.A. Basic Assumptions for Effects Assessment

IV.A.1. Significance Thresholds

The Council on Environmental Quality (CEQ) National Environmental Policy Act (NEPA) regulations (40 CFR 1508.27) define the term "significantly" in terms of both context and intensity. "Context" considers the setting of the Proposed Action, what the affected resource might be, and whether the effect on this resource would be local or more regional in extent. "Intensity" considers the severity of the impact, taking into account such factors as whether the impact is beneficial or adverse; the uniqueness of the resource (for example, threatened or endangered species); the cumulative aspects of the impact; and whether Federal, State, or local laws may be violated. Impacts may be beneficial or adverse. Impacts are described in terms of frequency, duration, general scope, and/or size and intensity. The significance thresholds used in the Sale 193 FEIS and this Final SEIS use terminology that is consistent with that definition.

The impact analyses address the significance of impacts on resources, with consideration of such factors as the nature of the impact (for example, habitat disturbance or mortality), the spatial extent (local and regional), recovery times (years, generations), and the effects of mitigation (e.g., implementation of the oil-spill-response plan). Adverse impacts that are reduced by required mitigation to below the "significance thresholds" are considered "not significant."

This Final SEIS largely adopts the significance thresholds used in the Sale 193 FEIS, but revises the thresholds for five resources. The following are descriptions of significance thresholds for resources considered in the Sale 193 FEIS, including changes to the significance thresholds for Water Quality, Air Quality, Subsistence-Harvest Patterns, Sociocultural Systems, and Environmental Justice.

Water Quality

A significant effect on water quality is determined by any of the following: (1) the action is likely to violate its National Pollution Discharge Elimination System permit; (2) in the event of an accidental spill of crude or refined oil, total aromatic hydrocarbon or total aqueous hydrocarbon criteria for the Alaska marine or fresh-water quality standards are exceeded; or (3) the action is otherwise likely to introduce changes in the physical, chemical, or biological characteristics of the waterbody which cause an unreasonable degradation of the marine environment as determined in accordance with 40 CFR 125.122.

Air Quality

A significant effect on air quality is determined when (1) project-related emissions cause an increase in pollutant concentrations over the nearest onshore area of at least 20 square kilometers that (a) exceeds half of any of the National Ambient Air Quality Standards (NAAQS) (except for ozone), (b) exceeds half of the maximum allowable increase for any pollutant for the Prevention of Significant Deterioration (PSD) for a Class II area under 40 CFR 52.21(c) or 18 AAC 50.020(b), (c) is expected to exceed half the ozone NAAQS based on an analysis of the potential increase in the ozone precursor emissions of volatile organic compounds (VOC) and nitrogen oxides (NO_X); or when (2) design concentrations violate the NAAQS or the Alaska Ambient Air Quality Standards.

Biological Resources

A significant effect on biological resources is determined as follows: 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. Biological resources include whales, seals, walrus, marine and coastal birds, terrestrial mammals, lower trophic level organisms, and fishes.

Threatened and Endangered Species

A significant effect on threatened or endangered species is determined by 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, ESA consultation process would constitute a significant impact.

Economy

A significant effect on the economy is determined as follows: economic effects that would cause important and sweeping changes in the economic well-being of the residents or the area or the region. Local employment is increased by 20% or more for at least 5 years.

Subsistence-Harvest Patterns

A significant effect on subsistence-harvest patterns occurs when adverse impacts disrupt subsistence activities, or make subsistence resources unavailable, undesirable for use, or only available in greatly reduced numbers, for a substantial portion of a subsistence season for any community.

Sociocultural Systems

A significant effect on sociocultural systems is defined as a disruption of social organization, cultural values, and/or institutional arrangements with a tendency toward displacement of existing social patterns.

Environmental Justice

Significant effects in this category include impacts on human health or environment that cause disproportionate, high adverse effects on minority or low-income populations. This threshold would be reached in the event of significant impacts to either subsistence-harvest patterns or sociocultural systems (see above). Tainting of subsistence foods from oil spills and contamination of subsistence foods from pollutants would contribute to potential adverse human health effects. Concerns that subsistence foods could be contaminated could also affect human health.

Archaeological Resources/Historic Properties

Significant effects on archaeological resources or historic properties are indicated when an interaction between an archaeological site and an effect-producing factor occurs and results in the loss of unique, archaeological information.

IV.B. Natural Gas Development and Production Scenario

IV.B.1. Summary

The natural gas development and production scenario below (see also Figure 12) provides the framework for BOEMRE's analysis in response to the July 2010 remand from the U.S. District Court for the District of Alaska (*Native Village of Point Hope v. Salazar*, No. 1:08-cv-00004-RRB [D. Alaska]). The scenario is based on our review of the exploration, development, and production scenario in the Sale 193 FEIS, options for natural gas production and transportation, information on current and planned North Slope infrastructure, and the professional judgment of BOEMRE staff.

The Sale 193 FEIS scenario presumes that oil, solution gas, and condensate would be recovered, but only oil and condensate would be transported off-lease for the first 15 years (from 2020 to 2035). Further, the scenario presumes that the TAPS oil pipeline system will continue to operate through at least 2044. The Sale 193 FEIS scenario did not include production of natural gas. Natural gas in northern Alaska is described as "stranded" until a gas-transportation system to outside markets is constructed. At the time of preparation of the Sale 193 FEIS, a large-diameter gas pipeline was

Year	Recovery	Recovery	Consumed	Injected	Gas Cap recovery		Consumed	Gas Sales (Bcf/yr)	Gas Sales (MMcf/yr)	Gas Production wells
	Dissolved gas (Bcf/yr)	Dissolved gas (MMcf/day)	Gas (Bcf/yr)	Gas (Bcf/yr)	Gas (Bcf/yr)	Gas (MMcf/d)	Gas rate (Bcf/yr			
2005										
2006										
2007										
2008										
2009										
2010										
2011										
2012										
2013										
2014										
2015										
2016										
2017										
2018										
2019										
2020	62.6	172	13.5	49.1						
2021	81.2	222	17.5	63.7						
2022	95.1	261	20.5	74.6						
2023	95.1	261	20.5	74.6						
2024	95.1	261	20.5	74.6						
2025	95.1	261	20.5	74.6						
2026	83.7	229	18.0	65.7						
2027	73.7	202	15.9	57.8						
2028	64.8	178	14.0	50.9						
2029	57.0	156	12.3	44.7						
2030	50.2	138	10.8	39.4						
2031	44.2	121	9.5	34.7						
2032	38.9	107	8.4	30.5						
2033	34.2	94	7.4	26.8						
2034	30.1	82	6.5	23.6						
2035	26.5	73	5.7	20.8	50	137.0	5.0	45.0	123.3	10
2036	23.3	64	5.0	18.3	75	205.5	7.5	67.5	184.9	15
2037	20.5	56	4.4	16.1	100	274.0	10.0	90.0	246.6	20
2038	18.1	49	3.9	14.2	125	342.5	12.5	112.5	308.2	25
2039	15.9	44	3.4	12.5	150	411.0	15.0	135.0	369.9	30
2040	14.0	38	3.0	11.0	150	411.0	15.0	135.0	369.9	30
2041	12.3	34	2.7	9.7	150	411.0	15.0	135.0	369.9	30
2042	10.8	30	2.3	8.5	150	411.0	15.0	135.0	369.9	30
2043	9.5	26	2.1	7.5	150	411.0	15.0	135.0	369.9	30
2044	8.4	23	1.8	6.6	150	411.0	15.0	135.0	369.9	30
2045					150	411.0	15.0	135.0	369.9	30
2046					150	411.0	15.0	135.0	369.9	30
2047					150	411.0	15.0	135.0	369.9	30
2048					150	411.0	15.0	135.0	369.9	30
2049					150	411.0	15.0	135.0	369.9	30
2050					150	411.0	15.0	135.0	369.9	30
2051					120	328.8	12.0	108.0	295.9	24
2052					100	274.0	10.0	90.0	246.6	20
2053					80	219.2	8.0	72.0	197.3	16
2054					50	137.0	5.0	45.0	123.3	10
2055										
TOTAL	**1160**		**250**	**910**	**2500**		**250**	**2250**		

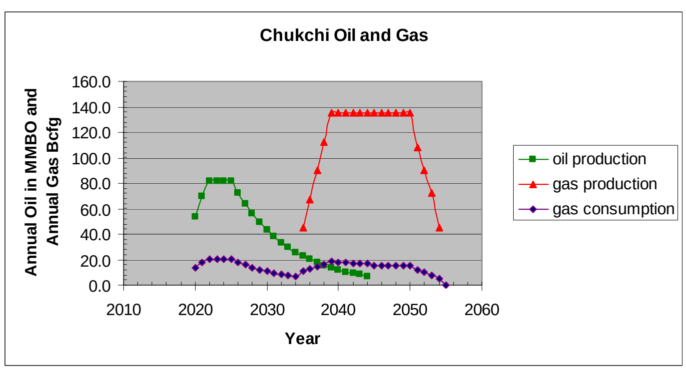

Figure 12. Scenario for gas production in the Chukchi Sea OCS begins as oil production decreases (illustrated below in Figure 13 and by the squares in the graph above).

considered the most likely transportation system; however, there were no specific proposals being considered at that time. BOEMRE considered it unrealistic to assume that natural gas would be economical to produce from the Chukchi Sea Planning Area until construction and operation of a gas-transportation system seemed likely.

Since completion of the Sale 193 FEIS, the Alaska Gasline Inducement Act (AGIA) was passed in 2007 by the State of Alaska to encourage construction of a gas pipeline from the North Slope to market. TransCanada was selected to pursue a pipeline project under AGIA. In addition, in 2007, BP and ConocoPhillips proposed the Denali pipeline project. Both pipeline groups held Open Seasons for prospective gas shippers in 2010. (Since then, the Denali project was abandoned in May of 2011.) Given these events, BOEMRE considered the construction and operation of a gas-transportation system more likely and included production of natural gas from the Chukchi Sea Planning Area in the Arctic Multi-Sale Draft EIS (USDOI, MMS, 2008a). Appendix E of the Arctic Multi-Sale Draft EIS provides a discussion of past and current gas pipeline proposals.

For this Final SEIS, BOEMRE estimates that approximately 500 million cubic feet of gas will be consumed as fuel by offshore and onshore facilities, leaving a gas sales volume of 2.25 trillion cubic feet (see Figure 12). Gas production would be phased-in around 2035, and peak gas production would start in 2039. All gas reserves would be depleted in 2054 (see Figure 12). During a 10-year transition period (2035 to 2044), both oil and gas would be produced from the offshore platform. Infrastructure required to support these activities includes a platform with topside facility, numerous wells, an offshore oil pipeline, an onshore processing facility, and an onshore pipeline through the NPR-A region.

IV.B.2. Background

Scenarios are conceptual views of the future and represent possible sets of activities. To develop scenarios, we consider the petroleum-resource potential of an area, the technology to develop and produce oil and gas from the offshore area, and industry trends in northern Alaska. While scenarios provide a reasonable basis for analyzing the effects of future activities, the presence and location of commercial oil or gas accumulation is purely hypothetical until proven by drilling. The primary purpose of a scenario is to provide a common basis for the analysis of potential environmental impacts, should future activities occur.

BOEMRE technical experts have reviewed the scenario laid out in the Sale 193 FEIS (see Sale 193 FEIS, Section IV.A.) and determined that it remains valid. The Proposed Action was presumed to result in leasing and exploration of the Chukchi Sale area, as well as the discovery, development and production of one large oil field. Recoverable oil resources from this field were presumed to be one billion barrels—lower oil volumes are not likely to be economically viable in this remote, high-cost location. At such a volume, an oil discovery could also be associated with a large volume of natural gas (in solution with oil and as a separate gas cap). Total potential of the initial reserve could be 2.75 trillion cubic feet.

Oil is a more valuable commodity than gas; this is not expected to change in the foreseeable future. Consequently, oil would be produced first. In a typical reservoir management strategy, solution gas recovered as a secondary product with oil is used as fuel for facilities, and the excess gas is injected into the reservoir to facilitate oil recovery. Later in the field life, as oil production rates decline towards depletion, gas can be produced for sale. The estimated timeframe for oil development activities is given in Figure 13. Overall, the timeframe from leasing to abandonment is projected to be 50 years.

IV.B.3. Infrastructure

Production would occur from a single platform; 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 (which precludes a floating production system), a large bottom-founded platform is likely to be used as a central facility. The platform would support 1-2 drilling rigs, production and service (injection) wells, processing equipment, fuel and production storage capacity, and quarters for personnel. The processing equipment installed on the platform would be initially designed for the peak oil and associated gas

Year	Seismic Surveys	Exploration Wells	Delineation Wells	Exploration Drilling Rigs	Production Platforms	On-Platform Wells	Subsea Wells	Service Wells	Production Drilling Rigs	In-Field Flowlines (miles)	Offshore Pipelines (miles)	New Shorebases	Annual Oil Production (MMbbl)	Daily Oil Production (bopd
2005														
2006	4													
2007	4													
2008	4													
2009	3	1		1										
2010	3	1		1										
2011	2		2	1										
2012	1		2	1										
2013	1		2	1										
2014	1	1		1										
2015	1	1		1								1		
2016	1													
2017											30			
2018											30			
2019							8		2	5	30			
2020					1	6	8	3	3	5			54.0	147,945
2021						18	8	5	4	5			70.0	191,781
2022						18	8	5	4	5			82.0	224,658
2023						18	8	5	4	5			82.0	224,658
2024						10	8	6	3	5			82.0	224,658
2025						10		4					82.0	224,658
2026													72.2	197,699
2027													63.5	173,975
2028													55.9	153,098
2029													49.2	134,726
2030												1	43.3	118,559
2031													38.1	104,332
2032											30		33.5	91,812
2033											30		29.5	80,795
2034											30		26.0	71,099
2035													22.8	62,567
2036													20.1	55,059
2037													17.7	48,452
2038													15.6	42,638
2039													13.7	37,521
2040													12.1	33,019
2041													10.6	29,057
2042													9.3	25,570
2043													8.2	22,501
2044													7.2	19,801
2045														
2046														
2047														
TOTAL	25	4	6	7	1	80	48	28	20	30	180		1000	

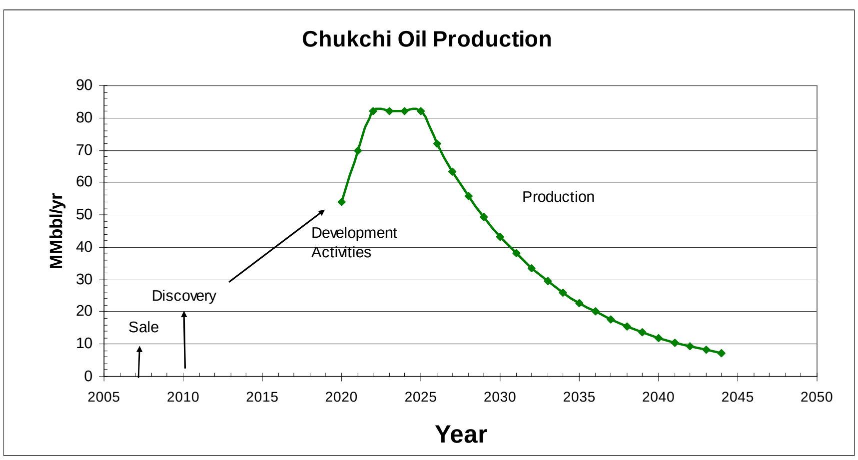

Figure 13. Sale 193 FEIS scenario for oil production, with the addition of offshore pipelines for gas now indicated in years 2032–2034. It is acknowledged that oil and gas activities in the Chukchi Sea have not come to pass as projected in the scenario for the Sale 193 FEIS.

rates (approximately 225,000 barrels/day and 260 million cubic feet/day; see Figure 13, above). In addition to the platform, oil production would require supporting infrastructure, including a shorebase, offshore oil pipelines, and an onshore oil pipeline across NPR-A to TAPS. To develop the oil reservoir, the platform would be installed near the center of the field area surrounded by subsea wells. Wells would be drilled from the platform and as subsea wells. On-platform wells would include both oil production and injection wells. Subsea wells (approximately half of the total number of production wells) may be up to 15 mi from the platform. Production from the subsea wells would be gathered to the central platform by small diameter, multi-phase in-field flowlines. The main part of the gas reservoir ("gas cap") is typically located near the center and (structurally) the highest part of the field because gas is a lighter substance than oil and water.

Raw production from the wells consists of a mixture of oil, gas and water that needs to be separated before transport through pipelines. After separation by processing equipment on the platform, formation water will be treated and injected into the subsurface. After separation and treatment, solution gas would be used as fuel for the facility or injected into the gas cap to maintain reservoir pressure so that more oil can be recovered. We assume that half of the estimated service wells (28 wells, see Figure 13) will inject water and half will inject gas into the gas cap. We also assume that 2 of the 28 service wells will be shallow disposal wells to handle waste water and treated well cuttings from drilling on-platform wells. Offshore facilities, the shorebase, and any necessary facilities along the onshore pipeline route will consume approximately 500 Bcf of gas during 34 years of operations (2020 to 2054) and the remaining gas reserves of 2.25 Tcf will be transported to market (see Figure 12).

IV.B.4. Development, Production, and Transportation of Natural Gas

Five underlying considerations are important to the discussion of a gas development scenario and are bulleted below. These factors suggest that the first commercial gas production will only occur when it can utilize existing oil production facilities because the higher value substance (oil) is needed to support the cost of the new infrastructure. It is, therefore, presumed that natural gas development and production is predicated upon, and would only follow, the oil exploration, development, and production activities analyzed in the Sale 193 FEIS.

Important considerations for gas development:

- **There is no transportation system at the present time to deliver natural gas from Arctic Alaska to market.** The abundant gas resources (proven and undiscovered) in this region will continue to be stranded until a large capacity gas transportation system is operational.
- **A large-diameter, overland gas-sales pipeline system is the most feasible and economically viable project to move large quantities of gas from Arctic Alaska to outside markets.** An important assumption of our gas production scenario is that a future North Slope gas-sales pipeline is built. Several gas-sales pipeline projects have been proposed by industry and strongly supported by Federal and State governments, although none have been constructed. At the present time, a new North Slope gas-sales pipeline is not expected to be operational until 2020. At least 10 to 15 years of available gas supplies have been identified close to this future gas-sales pipeline and will likely be produced and fill the gas-sales pipeline before remote gas fields can come online. We do not expect full-scale gas production from the Chukchi OCS or available capacity in the gas-sales pipeline until at least 2030.
- **Other gas transportation strategies (e.g. tankering of liquefied natural gas) have more difficult technical, regulatory, and economic challenges than an overland gas pipeline project.** These strategies were considered, but we found that they are much less likely to occur.
- **The economics of gas development are much less attractive than oil development.** The main disadvantage results from a price discount for gas compared to oil. A steep discount on an energy basis is expected to persist into the future. Despite the low market price for gas,

the development costs for new gas fields (platforms, wells, and pipelines) are very similar to oil. This unfavorable cost-price relationship burdens all gas projects.

- **Royalty Suspension Volumes are on a lease basis and are intended to encourage the development of both oil and gas resources.** On leases containing both oil and gas resources the RSVs will likely be depleted by the earlier oil production. On leases containing only gas resources (leases over the gas cap) the RSVs would be available when gas is produced for sale.

Other characteristics of the gas production scenario are:

- Gas production is expected to be delayed until most of the recoverable oil is produced.
- Gas production would briefly overlap declining oil production and last for another 20 years (see Figure 12). Overall, the timeframe for all activities (leasing to abandonment) could span 50 years.
- Gas production would utilize the same oil production platform described in the Sale 193 FEIS scenario.
- No additional exploration seismic surveys would be needed for gas development and production.
- No additional exploration drilling would be conducted for gas production.
- No new development drilling would be needed for gas development and production. Existing oil wells and gas injection wells would be used as gas production wells.
- No in-field flowlines would be needed or constructed.
- Natural gas liquid (condensate) would be separated from the gas stream and transported through the oil pipeline to market. Consequently, the gas pipeline would carry only dry gas (no water or condensates).
- No produced water discharges would occur. Any produced water would be treated and injected into the subsurface through existing disposal wells.
- A gas pipeline from the platform to the shore facilities would be needed. The new pipeline would be constructed during open-water season along same corridor as oil pipeline. Shore facilities are assumed to be near Wainwright.
- The oil production shore facilities would be expanded to accommodate gas processing. Administrative, maintenance, staff, buildings, and capabilities would continue to be used.
- A gas pipeline from the shore facility across NPR-A to the main transportation hub near Prudhoe Bay would be needed. The pipeline across NPR-A would be constructed on risers (vertical support members) during winter along the same corridor as the oil pipeline to TAPS.
- No hydrogen sulfide (H_2S) was recorded in any of the five historic wells drilled in open-hole conditions during 1989-1991: OCS-Y 1482 Klondike #1, OCS-Y 1275 #1 (Popcorn), OCS-Y 1413 #1 (Burger), OCS-Y 1320 #1 (Crackerjack), and Chevron OCS-Y 0996 #1 (Diamond) (Shell Gulf of Mexico Inc., 2009). Based on the absence of H_2S in any previously drilled exploration well in the Chukchi Sea, the Beaufort Sea, or the Canadian Beaufort Sea, H_2S is not expected in any natural gas produced from the Chukchi Sea Planning Area (Shell Gulf of Mexico Inc., 2009).

Aspects of gas development and production that may affect the human environment include: the presence of infrastructure (offshore platform, offshore and onshore pipelines, and shore base); noise and other disturbance from development activities; vessel, air, and ground transportation; emissions and discharges; and accidental events.

A timeframe for development and production is given in Figure 13. The platform would hold one or two drilling rigs, processing equipment, fuel- and production-storage capacity, and quarters for personnel. After the offshore platform is constructed for oil production and later modified for natural gas production, operations would largely involve resupply of materials and personnel, inspection of various systems, and maintenance and repair. Platform operations would transition from oil production to gas production during the last 10 years of oil production. Construction of a new gas pipeline to shore, expansion of the shorebase, and construction of a gas pipeline across NPR-A would occur during this transition period (2030 to 2035). The existing shorebase would be expanded and modified to support gas production. All necessary transportation (marine dock, airport, roads) and support (fuel storage, warehouses, crew quarters, and communication systems) infrastructure would have been constructed previously.

As many as 30 gas production wells are expected to be needed; however, all of these wells can be converted from existing wells from the oil production operations. The injection wells drilled into the gas cap of the reservoir (approximately 14 wells) would be converted to gas production wells. Many of the previously drilled oil wells are expected to produce higher and higher proportions of associated gas. Consequently, no additional well drilling is anticipated for full-scale gas production.

Installation of a subsea gas pipeline from the offshore platform to landfall would occur during summer open-water season. High-resolution seismic surveys and geotechnical studies to locate shallow hazards, obtain engineering data for placement of the pipeline, and to detect archaeological resources and certain types of benthic communities will be conducted along several potential routes. The offshore pipeline would be trenched into the seafloor as a protective measure against damage by floating ice masses. The gas pipeline is expected to be laid along the same corridor as the oil pipeline. The pipelines will be inspected and cleaned regularly by internal devices ("pigs").

An overland gas pipeline across NPR-A along the same corridor as the oil pipeline would transport gas to the main transportation hub near Prudhoe Bay where a gas-sales pipeline is expected to be located. Installation of the overland pipeline would likely occur during the winter months when tundra travel is feasible. Like the oil pipeline, the gas pipeline would be elevated. Several compression stations for the gas pipeline would be constructed along the pipeline. These facilities are likely to be co-located with onshore oil and gas fields along the pipeline route.

Offshore development activities would be supported by helicopters and supply vessels. Expansion of the onshore facility and construction of the overland pipeline would be supported by barges, aircraft, and perhaps winter ice roads. Transportation activities would be frequent during these development activities. The level of transportation in and out of the shorebase would drop significantly after development activities are completed. During production operations, there would be 1 to 3 helicopter flights offshore per day, and one vessel trip every 1 to 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.

To avoid potential disturbance effects on birds and marine mammals, BOEMRE, NMFS, and FWS recommend that aircraft maintain minimum flight altitudes—human safety will take precedence at all times over this recommendation. Information to Lessees No. 2 in the Sale 193 FEIS recommends a minimum flight altitude of 1,500 ft above seal level (ASL) and above ground level (AGL). The 2007 FWS BO specifies that aircraft remain above 1,500 ft over Ledyard Bay Critical Habitat Unit (Figure 1). The FWS' MMPA Incidental Take Regulations require a minimum altitude of 1,500 ft and a horizontal distance of 800 m (1/2 mi) from walrus hauled out on land or ice. The 2009 FWS BO continues to specify the minimum flight altitutde over Ledyard Bay Criticial Habitat Unit (USDOI, FWS, 2009: Figure 5.1).

After the gas reserves are depleted, the abandonment phase would begin. Wells would be permanently plugged (with cement) and wellhead equipment removed. Processing modules would be moved off the platform. Pipelines would be decommissioned, which involves cleaning the pipelines, plugging both ends, and leaving them in place (buried in the seabed). The overland oil and gas pipelines are likely to be used to develop oil and gas fields in the NPR-A, so they would remain in operation. Finally, the platform will be disassembled and removed and the seafloor site would be restored to a practicable, predevelopment condition. Surveys would be required to confirm that no debris remains and that the drill site and pipelines were abandoned properly. The abandonment process could take several years.

IV.B.5. Potential for Natural Gas Releases

This analysis evaluates the potential for a large gas release during natural gas development and production, as well as the potential impacts of such releases on the environment. This analysis identifies three general types of potential releases: from loss of well control at production platforms, from ruptured pipelines, and from onshore facilities. The following subsections discuss possible ways in which natural gas may be released into the environment, assign probabilities to notable events, and present release scenarios for further environmental resource-specific analysis.

Loss of Well Control

It is possible that a loss of well control during natural gas production could cause a release of natural gas into the environment. The Sale 193 FEIS, Appendix A, discusses the rates for loss of well control during drilling, which includes workovers—estimated at 5.9×10^{-3} blowouts per well drilled by Holland (1997). The production well control incident rate for production of both oil and gas is 5.0×10^{-5} blowouts per well year (Holland, 1997). Appendix B of this EIS discusses updated rates for loss of well control from drilling. The well control incident rate during production is lower than the during the development drilling phase. It should be noted that the natural gas development and production scenario analyzed in this SEIS does not entail the drilling of any new wells, but could include workovers.

During sales-gas production, which would commence in 2035, it is estimated that one well control incident of a single well on the facility could occur, releasing 10 million cubic feet of natural gas for 1 day. This is based on the average well production for one day from one well and estimated rates of blowout duration for production wells.

Ruptured Pipeline

Although unlikely, there exists some potential for a gas pipeline to rupture. The estimated rate of offshore gas pipeline ruptures in the Gulf of Mexico is 2.4×10^{-5} per mile-year (USDOI, MMS, 2009). For a 90 mile pipeline, over a 20 year production life, the estimated number of incidents is 0.04 offshore pipeline ruptures over the life of the project. The estimated rate for generic DOT onshore gas transmission lines from 1990-2009 is 1.5×10^{-4} per pipeline mile-year. For a 300 mile onshore pipeline, over a 20 year production life, the estimated number of significant incidents using DOT's estimated rate is 0.9 pipeline rupture over the life of the project. Under DOT regulation, significant incidents are incidents that involve property damage of more than $50,000, injury, death, release of gas, or that are otherwise considered significant by the operator.

A major release of natural gas would cause a sudden decrease in gas pressure, which in turn would automatically initiate procedures to close the valves on both ends of the ruptured segment of pipeline. Closure of the valves would effectively isolate the rupture and limit the amount of natural gas released into the environment. Given the daily flow rate and the estimated total number of valves, it is estimated that approximately 20 million cubic feet could be released within one pipe section between two valves.

Onshore, from an elevated pipeline, or from an offshore platform, the gas would disperse into the atmosphere. Offshore, from a subsea pipeline release, the gas would bubble to the surface and continue into the atmosphere, where it would dissipate at water temperatures greater than -2 °C. In temperatures lower than -2 °C, sea ice forms and gas could rupture the ice, be released through flaws, leads, fractures or polynyas or be trapped and then encapsulated into the growing ice sheet within 18-72 hours (Dickins and Buist, 1981; Fingas and Hollebone, 2003). Recent work (Semiletov et al., 2004) has demonstrated the usual assumption that the sea-ice cover is a barrier to gas exchange between the upper ocean and the atmosphere might need to be reconsidered for ice temperatures greater than -10 °C based on the original work of Gosink et al. (1976). This would mean gas could be released at temperatures lower than -2 °C. For purposes of analysis, it is estimated that pockets of natural gas under ice could persist from 1 to 3 days under large continuous ice sheets and could be distributed over 2 square kilometers, assuming a 30 cm depth as the ice pack moved.

Onshore Facility

Although unlikely, due to the enclosed space, there exists some potential for a gas leak and explosion at the onshore facility. The greatest hazard as a result of a natural gas leak is a fire or explosion. Methane has an auto-ignition temperature of 1,000 degrees Fahrenheit and is flammable at concentrations between 5 to 15 percent in air. Unconfined mixtures of methane in air are not explosive. However, a flammable concentration within an enclosed space in the presence of an ignition source can result in a potential explosion hazard.

Gas Release Fate

Natural gas is primarily made of up methane CH_4 and ethane C_2H_6 which make up 85-90% of the volume of the mixture. Propane, butane, and heavier hydrocarbons can be extracted from the gas system and liquefied for transportation and storage. These are commonly known as liquid petroleum gas or LPG. Pentane through decane are the intermediate-weight hydrocarbons and are volatile liquids at atmospheric temperature and pressure. The common names for these are pentanes-plus, condensate, natural gasoline, and natural gas liquids. Accidental condensate spills were analyzed in Sale 193 FEIS (USDOI, MMS, 2007a). Produced gas is expected to be dry gas (no water or condensates).

The primary component of natural gas is methane, a colorless, odorless, and tasteless gas. It is not toxic in the atmosphere, but is classified as a simple asphyxiate, possessing an inhalation hazard. As with all gases, if inhaled in high enough concentration, oxygen deficiency could occur and result in suffocation. The specific gravity of methane is 0.55 (Air = 1.0). Being lighter than ambient air, it has the tendency to rise and dissipate into the atmosphere.

Environmental Impacts

The potential environmental impacts of natural gas releases are discussed, as applicable, within resource-specific portions Chapter IV.

IV.C. Effects of Natural Gas Development and Production

The natural gas development and production scenario applies to each of the three action alternatives (Alternative I - Proposed Action, Alternative III-Corridor I Deferral, and Alternative IV-Corridor II Deferral). The scenario assumes that the production platform would be constructed near the center of the Sale 193 area, outside of the deferral areas presented in Alternatives III and IV. This location would be available for leasing under each alternative. The hypothetical location of the shore base and the routes of both offshore and onshore pipelines remain constant under the three action alternatives in the scenario. Differences in potential environmental impacts associated with each action alternative are directly traceable to the size and location of deferrals or absence thereof. For example, deferral corridors can influence the distance from shore of platform-related activities, support vessel and aircraft routes, and the length of an offshore natural gas pipeline. Under Alternatives I, III, and

IV, the production platform would be located a minimum distance of approximately 29, 65, and 35 miles from shore, respectively. If the shore base changed location to achieve the shortest possible distance from shore for the platform under each alternative, then the distances would be 12, 60, and 20 miles respectively.

The development and production of natural gas from existing infrastructure would not require any additional exploration activities. The potential effects from exploration activities, including various types of seismic surveying, are fully analyzed in the Sale 193 FEIS. Relevant conclusions of that analysis are also summarized in Chapter II of this Final SEIS. Because no additional exploration activities would occur as a result the natural gas development and production scenario, there is no need to duplicate a full impacts analysis of exploration activities in this Final SEIS. Further, no additional mitigation measures, beyond those analyzed in the Sale 193 FEIS, have been identified in regard to natural gas development and production activities. Standard mitigation measures and regulations are discussed, as appropriate. A full list of references for the data and major assumptions behind this analysis are available in the Sale 193 FEIS. Many of these references are retained in this Final SEIS to contextualize the present discussion. All new information used to support this natural gas analysis is cited accordingly.

Under the No Action alternative (Alternative II), the Secretary would decline to affirm Sale 193. No offshore development or production would occur under Sale 193, although such activities could occur within the Chukchi Sea under a future lease sale. Therefore, potential environmental impacts to marine, coastal, and human environment from offshore development and production would not occur or would be delayed. Economic benefits to local communities, the North Slope Borough, the State of Alaska, and the Federal Government would not be realized at this time, due to delay and/or missed opportunities. This alternative would also postpone potential contributions to national energy supplies and security. A variety of adverse and beneficial impacts generally associated with petroleum production could be displaced to other localities, both domestic and foreign. No additional mitigation measures have been identified in this Final SEIS for the No Action alternative.

Subsequent to the publication of the Sale 193 FEIS, BOEMRE prepared a Draft EIS for the proposed Arctic lease sales remaining in the 2007-2012, Five-Year Program (Sales 209 and 217 in the Beaufort Sea and Sales 212 and 221 in the Chukchi Sea) (USDOI, MMS, 2008a). This Draft Arctic Multi-Sale EIS was published in November 2008. The Draft Arctic Multi-Sale EIS used the most recent and best available information to update description of the OCS environment and analyzed resources. The Arctic Multi-Sale Draft EIS evaluated the potential environmental effects for leasing, exploration, and development and production of both oil and gas resources. The reader is referred to the Arctic Multi-Sale Draft EIS for a comprehensive update for the Arctic OCS.

Analysis of potential impacts uses the same organization as the Sale 193 FEIS, without regard to recent changes in a status of certain species under the ESA. Potential impacts to Pacific walrus, bearded seals, and ringed seals are considered within Section IV.C.10, Other Marine Mammals. Potential impacts to the yellow-billed loon are considered within Section IV.C.9, Marine and Coastal Birds.

IV.C.1. Water Quality

Consistent with regulations (40 CFR 125.122) implementing the Clean Water Act, determining impacts to water quality resulting from marine discharges is made based on consideration of the following ten criteria:

- 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.
- Applicable requirements of an approved Coastal Zone Management Plan.
- Marine water quality criteria developed pursuant to Section 304(a)(1).
- Such other factors relating to the effects of the discharge as may be appropriate.

Effects from Natural Gas Development

Relatively little additional development would be needed for natural gas development to proceed from the existing oil production platform. No additional drilling would occur, precluding additional disturbance and greatly reducing the potential for most discharges. Natural gas development activities that may affect water quality in the area include construction of a gas pipeline from the platform to the onshore facility, expansion of the onshore facility, and construction of a gas pipeline from the onshore facility across the NPR-A.

Degradation of marine water quality could result from installation of the gas pipeline from the platform activities. Sediment resuspension and bottom disturbances are likely to occur as a result of installing and burying the subsea pipeline. The area, duration, and amount of turbidity would 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 extent of the area affected could potentially vary under each of the action alternatives in that an increase in the areas deferred from leasing could result in an increase in the length of the platform-to-coast offshore gas pipeline. In the Chukchi Sea Planning Area, the sea bottom within 80 km of shore is mostly sand; farther from shore, the bottom is mostly mud (Lewbel, 1984). Turbidity typically would extend 3 km from trenching operations. Turbidity would increase over a few square kilometers in the immediate vicinity of dredging operations only during actual dredging. Conditions typically return to ambient conditions within hours to days, depending on the amount, composition, and frequency of the disposals. Discharges of pollutants and dredge and fill material are regulated under State and Federal permitting processes which require project-specific environmental assessment and documentation.

Construction of natural gas operations, including dredging and laying a seafloor pipeline, expansion of an onshore facility and placement of a gas pipeline onshore would cause negative impacts on water quality. The local effects on water quality from construction activities are expected to be short-term and constitute a low level of effect overall. Regional effects to water quality are expected to be very low.

Effects from Natural Gas Production

Natural gas production under Sale 193 would cause little to no adverse impacts to marine water quality.

Dry gas is expected to be produced during the gas production phase of the platform. Remaining produced water in the gas stream would be separated, treated, and injected into the subsurface through a disposal well. This would remove produced water as a potential source of water quality degradation.

Three waste-stream discharges during gas production could degrade water quality: deck drainage, sanitary waste, and domestic waste. 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. Pollutants, such as detergents used in platform and equipment washing, oil, grease, workovers fluids, and various other chemicals used during normal operations may be present in deck drainages. Chemicals may include ethylene glycol, lubricants, fuels, biocides, surfactants, corrosion inhibitors, cleaners, solvents, paint cleaners, bleach, dispersants, coagulants, and any other chemical used in the daily operations of the facility. Deck-drainage discharges are not continuous discharges and vary significantly in volume. Low Arctic temperatures prevent high volumes of deck drainage during the long winter months, and precipitation drainage is expected to occur only during the open-water (summer) months. Small quantities (<300 gallons per day) of deck drainage are expected during the gas-production phase of the platform. Higher quantities may occur during periods of high precipitation. Because of the remoteness of the platform and storage limitations, sanitary and domestic wastes are expected to be treated and discharged into marine waters. These discharges would be subject to NPDES permitting and associated water quality-based limitations, as well as associated monitoring requirements. Unreasonable degradation of water quality would be avoided in this manner.

The effect on water quality would be local and would continue for the life of the discharge. The effect on local water quality from gas production is expected to be moderate, 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 natural gas is unlikely.

In the event of a natural gas release, methane would be released into the water and proceed to rise through the water column as a function of pressure and temperature. When released in a blowout or rupture at depth, quality of the water would be altered temporarily and in deeper, colder waters, some of the natural gas would enter the water as a water-soluble fraction. Upon reaching the surface the gaseous methane would react with air, forming carbon dioxide (CO_2) and water which would then disperse into the atmosphere. The near-surface water quality would have higher concentrations of CO_2 than is natural and could, therefore, affect processes and reactions at the water-air interface. Depending on the size of the event, the effects on water quality would be temporary to short-term and would be negligible to minor in quality.

Conclusions

Neither natural gas development nor production is expected to cause significant adverse impacts on water quality. Temporary adverse effects are likely to result from installation of a new offshore natural gas pipeline and from small scale and infrequent deck drainage discharges. The effect of these activities on regional water quality would remain very low under each action alternative.

IV.C.2. Air Quality

The type and relative amounts of air pollutants generated by offshore operations vary according to the phase of activity. There are three principal phases of OCS operations: exploration, development, and production. No exploration activities associated with the gas production are expected. Impacts to air quality would result from the discharge of air pollutants from industrial equipment associated with natural gas support, development, and production activities.

Effects from Natural Gas Development

Emissions from development would result from the construction of an offshore pipeline, expansion of onshore support facilities, and construction of up to 300 mi of onshore pipeline across NPR-A. The main sources of emissions would include:

- heavy construction equipment used to install the platform-to-shore pipeline;
- construction and support equipment, including cranes, generators, compressors, welders, heaters, and safety flares; and
- tugboats (needed to move equipment and supply barges), support vessels, and helicopters.

The main emissions would be nitrogen oxides (NO_x) and carbon monoxide (CO), with lesser amounts of sulfur dioxide (SO_2), volatile organic compounds (VOC), and particulate matter (PM). The best available control technology (BACT) is expected to be used and would be required if emissions for the project where determined to exceed PSD Class II limits under USEPA or ADEC air quality regulations.

Effects from Natural Gas Production

The types of emissions sources and their emission rates would not be substantially different from those associated with oil production alone. The main sources of emissions during gas production would include:

- production equipment, including generators, turbines, pumps, gas compression equipment, boilers, heaters, and storage tanks;
- gas processing at the onshore facility; and
- support activities, including vessel and aircraft traffic.

The main source of offshore emissions during the production phase would be from turbines used for power generation, gas compression, oil pumping, and water injection. Other sources of emissions would be evaporative losses of VOCs from tanks, pumps, compressor seals, and valves. Reductions in VOC emissions are expected as a result of equipping tanks and valves with seals designed to prevent VOC leakage. VOCs would also be emitted if there were an accidental release of gas emitted during flaring and 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 VOCs, although some emissions of NO_x, carbon dioxide, SO_2, and PM would be released.

A noticeable increase in O3 concentrations onshore is not likely to result from offshore development or production. Photochemical pollutants such as ozone are not emitted directly; instead, ozone forms in the atmosphere through interaction with precursor pollutants (mainly, NOX and VOC) in the presence of sunshine and heat. Although sunshine is present in the Chukchi Sea Planning Area, summer days are cool (Brower et al., 1988). The World Meteorological Organization stores National Oceanographic and Atmospheric Administration (NOAA) data from a monitoring station in Barrow, Alaska, providing continuous hourly measurements of ozone concentrations (WMO, 2010). The data for 2010 showed increasing trends in ozone concentrations in the fall and winter with the lowest values in the spring and summer. However, the data showed a large range of values in the spring, the highest to the lowest ranging from 0.005 to 0.047 ppm in April (WMO, 2010). Because the O3 precursor emissions from development and production of a single gas field in the Chukchi Sea are expected to be considerably lower than the existing emissions from the Prudhoe Bay/Kuparuk/Endicott complex, the gas development and production is not expected to cause O3 concentrations to exceed the Federal standards.

In the 2008 Arctic Multi-Sale Draft EIS for the Beaufort Sea and Chukchi Sea Planning Areas Oil and Gas Lease Sales 209, 212, 217, and 221 (USDOI, MMS, 2008a), projected estimates were made of the total emissions of carbon dioxide (CO_2) and methane (CH_4) from projected oil and gas activities associated with the proposed Chukchi Sea lease sales (Sales 212 and 221) (USDOI, MMS, 2008a). Emissions factors for the various activities were largely based on a comprehensive inventory of air emissions from OCS activities in the Gulf of Mexico for the year 2000 (Wilson, Fanjoy, and Billings, 2004).

In the time since the publication of the 2008 Arctic Multi-Sale Draft EIS, the USEPA has published a revised greenhouse gas inventory for the U.S. (USEPA, 2011), and the Intergovernmental Panel on Climate Change (IPCC) began work on the Fifth Assessment Report (AR5); the AR4 was completed in 2007. The United Nations Statistics Division estimates the 2008 global budget of CO_2 emissions at 29,862 million metric tons (UN, 2011). The U.S. contribution is 5,921.0 million metric tons, approximately 19.8% of total global CO_2 emissions (USEPA, 2011). The U.S. budget of CH4 emissions is 686 million metric tons. The estimated maximum CO_2 emissions from proposed oil and gas operations in the Chukchi Sea is expected to be 0.482 million metric tons, while emissions of CH_4 are estimated to be 0.002 million metric tons. These statistics are summarized in Table 1.

Table 1. Projected greenhouse gas emissions from the production activities associated with the Proposed Action.

Greenhouse Gases (GHG)	Maximum Projected Project-Related GHG Emissions (million metric tons)	Total 2008 U.S. Emissions of GHG (million metric tons)	GHG Emissions from Chukchi Sale (as percent of U.S. total)
CO_2	0.482	5,921.4	0.0081
CH_4	0.002	686.3	0.0003
Total	**0.484**	**6,607.7**	**0.0084**

The amount of black carbon associated with natural gas production would be relatively small on the global scale. Consumption of diesel, natural gas, and other fuels produces less black carbon as compared to oil and coal, and Clean Air Act regulations would require appropriate technological controls of these activities. In the natural gas development and production scenario (and for that matter, in the oil exploration, development and production scenario analyzed in the 193 FEIS), black carbon emitted from combustion sources could be deposited on nearby snow and ice, contributing to melt rates on a local scale. Given the brief temporal nature and limited scope (i.e. few vessels) of development activities, and the fact that production activities are primiarly fueled by natural gas (which produces only very small amounts of black carbon), no significant impacts to the local environment would be expected.

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—those that had the most restrictive meteorological conditions in terms of visibility—but no effects at all during average meteorological conditions. We expect that those results would be representative of gas development in the Chukchi Sea Planning Area.

The effects of emissions from production activities are expected to cause small, local, and temporary increases in the concentrations of criteria pollutants. Consequently, we consider the effect of gas production on air quality to be low.

Conclusions

The potential increase in emissions from implementing the Proposed Action would be minor and any increase in criteria pollutant concentrations would be local and temporary. Further, the Proposed Action would meet all the requirements of Section 176(c)(1) of the Clean Air Act and would comply with the requirements of the Alaska State Implementation Plan for the control of air pollutants on the North Slope. The Proposed Action would not cause new emissions that would equal or exceed any standard of the NAAQS or the Alaska AAQS. Under the various deferral alternatives to the Proposed Action, air emissions would occur at a greater minimum distance from the coast, thereby decreasing the impact to inhabited areas. However, there could be a slight increase in total emissions due to the increased minimum distance that vessels must travel to reach leased parcels.

IV.C.3. Lower Trophic Level Organisms

Several aspects of the new natural gas production scenario could potentially impact lower trophic level organisms, specifically installation of a new platform-to-shore pipeline and extended operation of the platform and associated infrastructure. Localized and temporary adverse impacts can be expected from these activities. Minimal impacts to lower trophic level organisms are expected from the expansion of the onshore facility, installation of a gas pipeline across the NPR-A, or other components of the natural gas development and production scenario.

Effects from Natural Gas Development

Natural gas development and production would be predicated on the existence of oil development and production infrastructure. The oil scenario analyzed in the FEIS envisions a single production platform with a footprint of several acres. Relatively little additional development would be needed for natural gas production to proceed. Most of these new activities, such as recompletion of wells, expansion of the topside facility, associated vessel and aircraft traffic, expansion of the shore base, and installation of a onshore pipeline across NPR-A would have minimal long-term population level impacts on lower trophic level organisms.

The installation of an offshore pipeline to connect the platform with the onshore facility, however, would adversely impact lower trophic level resources. This new offshore gas pipeline would be buried about 12 feet deep – deep enough to minimize the potential for disruption from ice keels. The pipeline corridor, approximately 70 feet wide, would run parallel to the existing offshore oil pipeline over an estimated distance of 30-150 miles, disturbing roughly 1,000-2,000 acres of typical benthic organisms. Some of this area will have already been disturbed during installation of the offshore oil pipeline. The extent of the area affected could vary under each of the action alternatives in that an increase in the areas deferred from leasing could result in an increase in the length of the platform-to-coast offshore gas pipeline.

This action would disturb a seafloor that is currently inhabited by mollusks (clams) and other fauna that are particularly abundant in the northern and northeastern parts of the proposed lease area (Feder et al., 1994: Fig. 4b). Recovery times for benthic communities were studied by Conlan and Kvitek (2005) as a response to 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 and amphipods) but predicted recolonization of the original community would require many years. Two ice scours 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 large clams on which walrus usually feed are probably some of the last organisms to recolonize disturbed areas. 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. Based on these studies, the scenario assumes that the recovery time would require slightly more than a decade. The disruption of 1,000 to 2,000 acres of benthic organisms, requiring approximately 10 years to recover, could cause lethal impacts for those individuals in the affected area, but would not cause population-level impacts on a regional scale. Any overlap between the new offshore gas pipeline corridor and the existing offshore oil pipeline corridor would minimize the distribution of adverse impacts.

The anchoring of vessels supporting various gas development activities will cause some continuing bottom disturbance on a small scale. These adverse impacts are expected to be of limited duration and minor.

Effects from Natural Gas Production

Natural gas production under Chukchi Sea Lease Sale 193 would cause little to no adverse impacts to lower trophic level organisms. No additional drilling at the production platform would occur, precluding additional disturbance and greatly reducing the potential for most discharges. It is expected that any gas produced under Sale 193 would be dry gas. If present, any produced water will be of minimal quantity. Any remaining produced water in the gas stream would be separated, treated, and injected into the subsurface through a disposal well. This would remove produced water as a potential source of water quality degradation.

In the event of a large release of natural gas, primary concerns to benthic environments are the pressure of the outflow, makeup of the gas concentrates (and percentages of gas solids), mud or sediment components, and physical factors causing dispersal of ejected materials in the immediate affected environments (Solheim and Elverhoi, 1993). Pressure of gas deposit will determine both the amount of methane escaping from the site and the force at which it will be ejected from the sub-benthic surface. In turn, the amount of force combined with percentage of mud, silt, or sand will directly affect the plume ejected from the blowout site and the capacity of the resulting discharge to be deposited in the areas adjacent to the blowout site (Rye, Brandvic, and Strom, 1997). Plumes with higher density, or higher sand content, will be deposited at shorter distances from the blowout site relative to high percentages of silt or mud, which would be suspended in the water column and deposited farther from the well site (Johansen, 2000). Physical factors, such as current direction and speed, wind speed and direction, and presence or absence of ice cover, will influence the deposition on nearby benthic environments (Birtwell and McAllister, 2002). Deposition of ejected substrate material onto nearby benthic resources could severely affect the capacity of localized resources to support benthic and epibenthic invertebrate and vertebrate populations, including Essential Fish Habitat, for one or more years. However, recovery would occur in less than three generations, and overall impacts would be localized and temporary and not significant.

Conclusions

Several components of the natural gas development scenario, such as installing an offshore gas pipeline and anchoring vessels, have the potential to impact lower trophic level organisms. However, these impacts would be localized and temporary, given the strong expectation of recolonization. As a result, no adverse long-term population level impacts to lower trophic level organisms are expected to result from natural gas production. Therefore, no significant adverse effects on this resource would occur.

IV.C.4. Fish Resources

Activities which directly impact habitat or produce high levels of noise or pollution can measurably affect fish populations. Relevant impacts can include short- and long-term displacement from work areas due to emitted underwater sounds and sediment plumes, short-term losses of seafloor habitats, and multiyear injury/mortality in a “zone-of-influence” near sources of pollution. Some fish, particularly sedentary or bottom-obligate fish, could be harmed or killed under the above conditions. Pelagic swimming fish are more able and likely to avoid these activities.

The following activities associated with the natural gas development and production scenario have the potential to affect fish: trenching seafloor to place a gas pipeline from platform to shore; regulated or unregulated discharges from platform; vessel noise; platform operating noise; and pipeline construction across NPR-A. These activities would overlap marine and freshwater salmon EFH (adult, juvenile, eggs) and Arctic cod marine EFH (adult, juvenile) in some areas. The potential effects would include: physical disturbance of fish habitat; alterations in quality of water in which fish occur; disturbance, startle or displacement from noise; exposure of sedentary fish to discharges and repetitive noise. Some of these negative effects would be temporary and negligible; other negative effects (such as benthic habitat trenching and disturbance to spawning behavior or habitat) would have longer-term effects.

Effects from Natural Gas Development

Relatively little additional development would be required to transition from oil production activities to natural gas production activities. There are some components of the natural gas development scenario, however, that could affect fish resources by disturbing portions of the Chukchi seafloor, emplacing an onshore pipeline or by producing relatively high levels of noise.

Seafloor Disturbance

One activity that would cause direct disturbance of the seafloor is vessel anchoring, which may be necessary to support the development (and production) of natural gas. Anchoring could cause both direct and indirect impacts to fish resources. Direct impacts could occur if fish are crushed or injured during anchoring or weighing anchor. Indirect impacts to fish resources may occur should an anchor damage sessile organisms (e.g., kelp) or their habitats (e.g., boulders). Such damage is possible under certain conditions when anchors fail to hold fast and drag across the seafloor. 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 a few known kelp beds in the Chukchi Sea, but they are located nearshore or in coastal lagoons, unlikely sites 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.

The installation of new gas pipelines could also cause direct and indirect impacts to fish resources. The offshore gas pipeline would extend shoreward from the production platform for a distance of between 30-150 miles. Trenching would be necessary to protect against damage by ice in all water depths under 165 ft (50 m). Both trenching and actual pipelaying would take place during the short open-water season or during mid- to late winter, when landfast ice has stabilized. In addition to disturbing a long corridor of seafloor, trenching would temporarily increase turbidity around the project footprint. Depending on the nature of the substrate, this turbidity could either remain for short amounts of time or be moved offsite into other areas. At a coastal landfall, the pipeline likely would be elevated on an existing, short gravel abutment extending less than 100 m offshore (assuming one is constructed during the oil development phase) to protect it against shoreline erosion. Overall, installation of the new offshore gas pipeline would cause direct and indirect impacts similar to vessel anchoring, but would do so on a much larger scale. Though adverse impacts would be expected, they would remain temporary and localized. The extent of the area affected could potentially vary under each of the action alternatives in that an increase in the areas deferred from leasing could result in an increase in the length of the platform-to-coast offshore gas pipeline.

The potential for adverse impacts would be minimized through the applicable regulatory processes implemented by BOEMRE and other Federal agencies. Pipeline permit applications to BOEMRE include the pipeline location drawing, profile drawing, and other relevant information. BOEMRE evaluates the design and fabrication of the pipeline and prepares an additional NEPA analysis. All pipeline rights-of-way that go ashore require an EA, if not an EIS. The NMFS and FWS also review and provide comments on applications for pipelines that are near certain sensitive biological communities. BOEMRE will not approve a proposed pipeline route 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. Lease Stipulation No 1—Protection of Biological Resources—which requires lessees to survey for, as well make every reasonable effort to preserve and avoid areas of biological significance—would further mitigate potential impacts.

The onshore gas pipeline across NPR-A also has the potential to adversely impact fish resources. However, there exist many more opportunities to proactively avoid or at least minimize potential adverse impacts. Installation of the long overland gas pipeline across NPR-A would likely occur in the winter months when tundra travel is feasible. The pipeline itself would be elevated on vertical supports and utilize the same corridor as the overland oil pipeline, which would already be in place. Appropriate avoidance and mitigation measures would be expected to result from the regulatory processes that apply to such projects. 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 habitats as dictated by Federal policy and law. These policies would guide reductions in direct construction impacts on fish-bearing streams and lakes through mitigation efforts 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 adverse impacts to fish and fish habitats, but recovery to previous levels would be expected to occur in fewer than three generations.

Noise

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. Most relevant to this discussion, fish can detect sounds (Popper et al., 2003) and changes in water-current (Coombs and Braun, 2003). Loud noises or intense changes in water pressure can elicit a startle response and disrupt fish behavior on individual and group levels. Although no additional seismic activities or well drilling would occur, two components of the natural gas development and production scenario would produce enough noise to potentially affect fish: vessel traffic and pipeline installation.

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 can also cause cavitation, and even small items of machinery might produce quite high levels of noise. Some, but not all relevant studies have noted avoidance behavior by fish subjected to loud noises from a vessel. Data also suggests that abnormal fish activity may continue for some time as the vessel travels away. However, vessel noise is inherently transient, rendering adverse impacts temporary. Fishes in the immediate vicinity of vessels may also exercise avoidance. In light of the above, vessel noise is likely to be of negligible impact to fish resources.

Noise-related disturbance effects on fish and direct loss or degradation of fish habitats are likely to occur during construction in the marine environment. Potential pipeline locations would be evaluated on a site-specific basis to avoid or minimize adverse construction-related impacts to fish habitats. The installation of the new pipeline would be anticipated to result in temporary and/or localized adverse impacts to fish and fish habitats. The minimum potential length of both the offshore gas pipeline as well as support vessel travel routes could vary under each action alternative given the fact that two alternatives include deferral areas of varying size.

Effects from Natural Gas Production

Noise

The production platform would require continued servicing from vessels which, as discussed above, produce noise when in transit. Vessel activity would be less frequent and be generally restricted to an area between the drill site and a land-based support site. Additional noise may occur through other aspects of gas production. All of these noise impacts, however, would have a low effect on fish resources.

Pollution

Although salmon and other fish species have exhibited sensitivity to polycyclic aromatic hydrocarbons (PAH) and pollutants associated with industrial activities, applicable regulations place strict standards on all production activities; the natural gas production scenario analyzed here would not measurably impact fish as a result of pollution.

Release of Natural Gas

Although most natural gas eventually rises to the surface of the water, some enters the water as a water-soluble fraction. This can include hydrocarbon mixtures that trigger behavioral and physiologic responses in adult and juvenile fish and present toxicity exposure to adult and juvenile fish, eggs and larvae. Depending on the size of the event, the toxicity effects on fish populations in the region would be negligible to minor. Fish life stages would also be exposed to physical aspects of a gas blowout or rupture at depth through sound produced by the explosion and release; pressure waves caused by the release; and bubble release, travel, and collapse. Behavioral, physiological or physical effects could occur as a result of adults, juveniles, larvae, and eggs being exposed to these physical effects of a natural gas blowout or rupture. Physical effects from the natural gas release described in the scenario would be negligible to minor on fish populations in the region.

Conclusions

Several types of direct and indirect impacts would occur as a result of the natural gas development and production scenario. Direct impacts, however, would be reduced to those fish that are able to avoid the disturbance. Impacts would occur to seafloor habitat from pipeline installation and anchoring. These effects cannot be avoided, however the effects would be within the definition of minor level.

IV.C.5. Essential Fish Habitat

The following activities associated with the natural gas production and development scenario were analyzed for their potential to impact essential fish habitat (EFH): trenching seafloor to place a gas pipeline from platform to shore; regulated or unregulated discharges from platforms; vessel noise; platform operating noise; and pipeline construction across NPR-A. These activities would overlap with marine and freshwater salmon EFH (adult, juvenile, eggs) and Arctic cod marine EFH (adult, juvenile) in some areas. It is also possible that certain activities could impact opilio crab EFH and saffron cod EFH, both of which are located in relatively close proximity to the lease sale area. The potential impacts would include: physical disturbance of fish habitat; alterations in quality of water in which fish occur; disturbance, startle, or displacement from noise; and exposure of sedentary fish to discharges and repetitive noise. Some of these impacts would be temporary and negligible; others (such as benthic habitat trenching and disturbance to freshwater spawning areas) would have longer-term impacts on habitat.

A separate EFH consultation document was submitted to NMFS in July, 2011. That document contains BOEMRE's formal EFH analysis and its determination that the Proposed Action may affect designated EFH.

Effects from Natural Gas Development

Trenching and the installation of new gas pipelines would affect essential fish habitat through physical disturbing along the pipeline corridors in the seafloor. Trenching would be necessary in water depths less than 165 ft (50 m) to protect the pipeline from damage by ice. Both trenching and pipe-laying would take place during the short open-water season or during mid- to late winter, when landfast ice has stabilized. In the mid-late winter, ice-habitat of Arctic cod could be affected.

Trenching would increase suspended sediment and turbidity around the project footprint. The transport and deposition of this sediment would vary with the composition and weight of sediment particles put into suspension along the pipeline corridors, for a distance ranging 30-150 mi. At landfall, the pipeline likely would be elevated on a short (extending less than 100 m offshore), solid-fill abutment to protect against shoreline erosion; depending on the location of landfall, this activity could affect salmon essential fish habitat.

The potential for negative impacts would be minimized through the applicable regulatory processes implemented by BOEMRE and other Federal agencies. Pipeline permit applications include the pipeline location drawing, profile drawing, and other relevant information. The BOEMRE evaluates the design and fabrication of the pipeline and prepares an additional NEPA analysis. The FWS also reviews and provides comments on applications for pipelines that are near certain sensitive biological communities. Lease Stipulation No 1—Protection of Biological Resources—which requires lessees to survey for, as well make every reasonable effort to preserve and avoid areas of biological significance—would further mitigate potential impacts to EFH.

An onshore gas pipeline across NPR-A would likely impact salmon essential fish habitat. Installation of the long overland gas pipeline across NPR-A would likely be in the winter months when tundra travel is feasible. The pipeline would be elevated on vertical supports and utilize the same corridor as the overland oil pipeline, which would already be in place. Appropriate avoidance and mitigation measures would be expected to result from the regulatory processes that apply to such projects. 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 from such structures 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 construction-related impacts to fish habitats associated with the proposed sale.

Effects from Natural Gas Production

Natural gas production would likely cause relatively low impacts once the natural gas development is completed. Vessel and production noise, regulated and unregulated spills or releases would continue to affect essential fish habitat. In the event of a large-scale natural gas release, the chemical and physical water column environment of Arctic cod essential fish habitat would be affected with impacts variable depending on the size and location of a release. Noise and a potential natural gas release could also negatively impact habitat that, while not officially designated at present, is most likely used by saffron cod and opilio crab during their larval stages.

Conclusions

The following activities associated with the natural gas production and development scenario would affect EFH: trenching seafloor to place a gas pipeline from platform to shore; regulated or unregulated discharges from platforms; vessel noise; platform operating noise; and gas pipeline construction across NPR-A.

These potential activities would overlap with marine and freshwater salmon EFH (adult, juvenile, eggs) and Arctic cod marine EFH (adult, juvenile) in some areas. It is also possible that certain activities could impact opilio crab EFH and saffron cod EFH, both of which are located in relatively close proximity to the lease sale area. The potential impacts would include: physical disturbance of habitat; alterations in water quality; disturbance, startle, or displacement of fish due to noise; and exposure of sedentary fish to discharges and repetitive noise.

In accordance with the Magnuson-Stevens Fisheries Conservation and Management Act, BOEMRE has submitted to NMFS in July, 2011 a consultation document addressing the effects of the proposed action on Arctic cod, salmon, saffron cod and opilio crab EFH. An analysis of effects and a final determination of effects, according to the Act, are made in that document.

IV.C.6. Whales – Threatened and Endangered

The aspect of natural gas development and production posing the greatest risk of impacts to whales is noise. Generally speaking, noise impacts on cetaceans can range from behavioral change (avoidance response, altered travel routes, etc.) to physical harm such as hearing loss, the latter of which can result (in serious cases) in an inability to communicate, detect, and/or echolocate. Sometimes even relatively low levels of noise not directly harmful to a whale itself can “mask” naturally-occurring noises upon which whales rely in order to perform basic functions such as communication, echolocation, and feeding. Noise impacts to cetaceans are largely dependent on the specifics of a given situation: i.e. the species affected; the age, sex and reproductive status; the accumulated hearing damage of an individual; and/or the size of the group of whales affected. Visual assessment of impacts can be problematic, as negatively impacted whales may continue certain behavior (e.g. feeding or migration) out of necessity.

The primary concern here is whether natural gas development and production activities could produce noise and disturbance sufficient to cause bowhead, fin, or humpback whales to avoid high value areas, thereby risking biological consequences. Avoidance response behaviors in gray, humpback and bowhead whales can occur at 120 dB re 1 μPa received sound levels. However, a majority respond at higher received sound levels at or above 160-170 dB re 1 μPa and some may not respond until received levels are louder still. Onset of behavioral disturbance from anthropogenic noise depends on both external factors (characteristics of noise sources and their paths) and the receiving animals (hearing, motivation, experience, activity, demography, etc.) and is also difficult to predict (Southall et al. 2007). Currently, NMFS uses 160 dB re 1 μPa at received level for impulse noises (such as airgun pulses) as the onset of marine mammal behavioral harassment.

The analysis below focuses on the potential effects on bowhead whales from natural gas development and production in the Chukchi Sea OCS. Fin and humpback whales are expected to react to natural gas development and production activities similarly to bowhead whales in terms of avoidance behavior, migration route alteration, or displacement from feeding areas; however, species specific thresholds for response may be different in some cases. Further, effects on fin and humpback whales would be limited to a few individuals because of the low numbers of these species that occur in the Chukchi Sea Planning Area. Impacts to each of these species could vary under each action alternative, given the different respective minimum distance from shore at which the platform could be constructed.

Effects from Natural Gas Development

Activities associated with the development of natural gas that could cause adverse impacts to Threatened and Endangered whales are the transit of marine vessels and aircraft, installation of an offshore gas pipeline, and to a lesser extent, recompletion of existing wells and expansion of the topside facility and shore base.

Potential Effects from Vessel Traffic

Gas development activities would lead to a temporary increase in vessel traffic to service the existing platform and support the installation of a new offshore gas pipeline. Some marine vessels including sealift and other barges and boats (but not including icebreakers) would be used in natural gas development activities. It is conceivable that cetaceans could be disturbed or struck by these vessels. As noted in discussion of the affected environment, baseline information indicates that current rates of vessel strikes of bowheads are low. At present, available data do not suggest that strikes of bowheads by oil and gas-related vessels will become an important source of injury or mortality.

The greater issue is noise. 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 historic commercial and continuing subsistence hunting. 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 μPa (decibels relative to one micropascal) or 6 dB above ambient may result in strong avoidance of an approaching vessel at a distance of 4 km (2.5 mi) (Richardson and Malme, 1993). Vessel disturbance has been known to disrupt activities and social groups. Fleeing from a vessel generally stopped within minutes after the vessel passed, but scattering may persist for a longer period. Parks et al. (2011) note for North Atlantic right whales (a species similar to bowhead whales) and Holt and Noren (2008) note for killer whales that individuals modified calls in response to increased background and vessel noise, respectively, by increasing the amplitude of their calls. McDonald, Hildebrand, and Mesnick (2009), however, noted the decline in blue whale song tonal frequencies was not fully explained by the hypothesis of increasing ocean noise. But these authors suggest that post whaling population increase is altering sexually selected trade-offs for singing males between song intensity (ability to be heard at a greater distance) and song frequency (ability to produce songs of lower pitch).

Where vessels approach slowly or indirectly, bowheads are much more tolerant, and reactions are generally less dramatic. The encounter rate of bowhead, humpback, and fin whales with vessels associated with natural gas development would depend on the location of the platform in relation to both shipping routes and areas of heavy use. 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 supply vessels to operate in. Bowheads, as with other “right whales” (family Balaenidae), are among the slowest moving of whales, which may make them particularly susceptible to ship strikes. Despite their likely greatest susceptibility to vessel strikes, records of strikes on bowheads are rare compared with records of strikes on some other large whales (Laist et al., 2001). About 1% of the bowhead whales taken by Alaskan Iñupiat bore scars from ship strikes (George et al., 1994). Until recently, few large ships have passed through most of the Western Arctic bowhead’s range but this situation is changing and the potential for increasing opportunity for vessel strikes may be increasing as northern sea routes become more navigable with the decline in sea ice. At present, bowheads, humpback, and fin whales probably would adjust their individual swimming paths to avoid approaching within several kilometers of vessels attending the production platform, and would also move away from vessels that approached them within a few kilometers (Richardson, et al., 1995, pp. 262-272).

Potential Effects from Aircraft Traffic

Gas development activities involve small and temporary increases in air traffic within the action area. Fixed wing aircraft may serve as whale spotters during pipeline route surveys or pipeline installation activities in the nearshore areas. The use of spotter aircraft could be an important mitigation technique that would reduce the overall potential for gas development to cause adverse impacts to whales. Helicopters are likely to be used to transport crews and supplies in support of modification of the production platform for gas development. Aircraft noise may elicit a response, such as a turn or hasty dive, from a whale or group of whales. But given the altitude at which these aircraft are expected to fly, the potential for adverse reactions is small. Any impacts that did occur would be temporary and minor. Under Alternatives III and IV, the minimum travel route to a platform would be longer; thus, there is a greater opportunity for these effects to occur.

Potential Effects from Construction Activities

Natural gas development would entail a variety of construction-type activities, to include expansion and maintenance of the topside facility and the onshore base, and most notably, installation of an offshore gas pipeline. These activities can impact Threatened and Endangered marine mammals in that they are relatively noisy. Both expansion projects would produce noise from stationary locations, and could thus be largely avoided by baleen whales. Despite the long, linear nature of pipelines, their construction is a slow-moving, relatively stationary operation. Thus, pipeline construction represents a similarly temporary and avoidable source of disturbance. To avoid or minimize adverse impacts, relevant organizations (i.e., project proponents, BOEMRE, NMFS) will need to develop timing guidelines and operational protocols to govern the specifics of this project. This review would take place at a later stage of review, when more site-specific information would be known.

Potential Effects from Abandonment

Some adverse impacts to whales may also occur during abandonment of natural gas production wells and the offshore gas pipeline. Abandonment operations include plugging and abandoning wells, decommissioning subsea pipelines, and removal of production equipment and platforms. Established procedures and regulations govern all these operations. 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. These activities are not expected to cause impacts to whales, apart from the possibility of vessel noise impacts as analyzed above.

Abandonment of wells, meanwhile, involves a very slight potential for more serious adverse impacts. During abandonment, 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. 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. Extensive monitoring (e.g. aerial surveys and passive acoustic monitoring) and implementation of mitigation to prevent harassment or injury would reduce the potential for adverse impacts. Overall, impacts from abandonment are expected to be low.

Any activity causing noise reaching 160 dB re 1 μPa would risk level B “harassment” take of whales, and require a take authorization under the MMPA. Additional mitigation measures required to avoid significant adverse impacts would be required by later BOEMRE and NMFS review processes. Detailed analysis of potential Exploration Plans and Development & Production Plans, along with mitigation measures incorporated into any necessary Incidental Take Authorizations (ITA), would further reduce the potential for any significant adverse impacts.

Effects from Natural Gas Production

Potential Effects from Disturbance

During natural gas production, operation and maintenance of the platform and related infrastructure could potentially affect ESA-protected cetaceans by introducing additional noise into local waters. Given the relatively low noise levels associated with normal production activities, and the fact that whales appear to exhibit less avoidance behavior with stationary sources of relatively constant noise than with moving sound sources, any such impacts would be temporary, avoidable, and minor.

Air support for crew rotations and supply deliveries would continue for gas production activities on the platform. This air support would consist of turbine helicopters flying along straight lines, making roughly one to three trips per day. Most bowheads are unlikely to noticeably react to occasional single passes by low-flying helicopters ferrying personnel and equipment to offshore operations. In fact, most bowhead whales exposed to helicopter overflights were observed to exhibit no obvious response to helicopter overflights at altitudes above 150 m (500 ft). Other studies confirm that peak sound levels received underwater diminished with increasing aircraft altitude. 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 are likely to resume their normal activities within minutes. Mitigation measures (whether implemented via BOEMRE, NMFS Incidental Take Rules, Section 7-ESA consultations, or other sources) which prescribe minimal altitudes for aircraft transiting through the action area will serve to further reduce potential impacts.

Potential Effects from a Natural Gas Release

The scenario for gas production entails the conversion of existing oil wells on production platforms to natural gas wells after oil recovery has been ongoing. There would be a period of years where oil and gas production would overlap. Accidental spills of condensates and oil were analyzed in USDOI, MMS (2007). Released gas would be expected to be dry gas with no condensates or water. There would be no effects on cetaceans from an onshore gas facility, including pipelines.

Effects from atmospheric release of natural gas from production platform facilities would have no effect on cetaceans unless explosion or fire results. Rapid dissipation of the lighter than air components of gas into the atmosphere and the localized short term nature of a release minimize the time of exposure and potential inhalation of fumes by cetaceans, and effects would be minor to negligible. In such cases, the visible presence of fire and smoke plumes, emergency activities to control the event, and the noise from an explosion would have potential temporary effects. Cetaceans, including bowhead, fin and humpback whales normally avoid noise and human activity similar to those occurring during control activities and operational noise from platforms. Noise from an explosion would be a single instant event and non-lethal to cetaceans.

Effects are possible in the event that a gas release occurs. An accident involving an ocean-bottom well-control device failure or undersea gas transport pipeline release could result from corrosion, breaks or other factors, and lead to a gas release. Undersea pipeline releases would be short term (up to one day) and limited to the volume of gas present between pressure-sensitive control valves—up to 20 million cubic feet of gas—that close when pressure is lost. Volume of gas is also dependent on pipe diameter and distance between control valves. Releases would be local and in the immediate area of the release. Methane and ethane natural gas components would likely bubble to the surface and dissipate in the atmosphere, given the shallow depths of the Chukchi Sea. Toxic effects upon baleen whale prey items would be negligible considering the low volume, short duration, rapid dissipation, and localized nature of a release. During the spring migration of bowhead whales and beluga whales through the spring polynya system or spring lead system (SLS), a temporary disruption of migration is possible if release/explosion/control activities occurred during the migration period, or when migrating animals are present and migrating through a release area. Short-term, non lethal avoidance of activity or startle behavior in response to an explosion or short-term release would be expected. Also, there is the potential for a short-term delay in migration or a detour movement avoiding the localized area of release. This would be considered a minor effect with no mortality or injury expected. Cavitation noise from the gas bubbles would be of short duration and dependent on the rate of gas release, but is not anticipated to reach levels that would injure or cause temporary hearing loss by cetaceans. It could, however, reach levels that may induce a startle or local avoidance response.

There are a number of considerations regarding effects of a major natural gas release under ice-covered conditions. First are the relationships among temperature (at the ice/water interface), condition of the ice (relative to motion), stress cracks, flaw zones, and leads. Second is the presence of beluga, bowhead, ice seals and other pagophillic species. Bowheads and belugas would be present in the Lease Sale 193 area (associated with the spring lead and polynya system) in the months of March through June of the ice cover period. During this period the mean sea-ice interface temperature is greater than -2.2 °C which is the threshold temperature whereby brine channels provide a pathway for encapsulated or trapped methane to the atmosphere. At temperatures below -2 °C gas ice continues to form downward, encapsulating gases within the ice. Estimates range from 18 to 72 hours for released and subsequently trapped gas beneath the ice to be encapsulated (when ice is forming beneath the ice sheet) depending on the time of year. Whales and sea mammals associated with the moving ice and broken ice found in leads and polynyas, flaw zones, stress cracks, and open water areas would rarely have large pockets of trapped methane available at the ice-seawater interface, because the diffuse fractures and open water areas would rapidly move methane gas through the ice and into the atmosphere. A large release of methane could also rupture the ice sheet and thus provide rapid movement of methane to the atmosphere. The possibility for methane trapped in large pockets is further reduced by movement and dispersal of methane bubbles through the water column. Moreover, currents and entrapment in small volumes will disperse bubbles of gas over a wide area due to the micro roughness of the bottom surface of the ice.

Breathing holes visited by ice seals and polar bears provide for a rapid venting of methane to the atmosphere and pose little risk to these species. Conceptually, some ringed seal dens could temporarily concentrate escaping methane as it slowly vents through the snow roof of such dens.

The deferral areas incorporated into Alternatives III and IV could increase the distance of a potential release from the platform to areas receiving more bowhead use. However, the probability and severity of any impacts associated with a release from the onshore facility would remain the same, and the risks associated with a release from the offshore pipeline, although remaining quite small, could increase with a lengthier pipeline.

Conclusions

Natural gas development and production could result in increased noise and disturbance to bowhead, fin, and humpback whales. Bowhead, fin, and humpback whales exposed to noise-producing activities such as vessel and aircraft traffic, construction activities, and production activities most likely would experience temporary, non-lethal effects. There is variability in whale response to certain noise sources; this variability appears to be context specific (e.g., feeding versus migrating whales) and also may be related to reproductive status and/or sex or age. Overall impacts to bowhead whales are expected to be temporary, non-lethal, and minor; effects on fin and humpback whales are expected to be temporary, non-lethal, and negligible.

IV.C.7. Polar Bears – Threatened and Endangered

To date, documented impacts to polar bears in Alaska by oil and gas development activities are few. The potential for adverse impacts is largely associated with increases in industrial activity or expansion of industrial footprints, as well as related increases in human/polar bear interactions. Because the development and production of natural gas stemming from Sale 193 would be predicated on existing oil production infrastructure, increases to the industrial footprint would be quite small when viewed on a regional scale. Minimal impacts could result from the potential increase in human/polar bear interactions associated with expanding the onshore facility, installing the offshore and onshore pipelines, and extending the production timeframe within the action area. The FWS and USGS have predicted that polar bears may be extirpated throughout much of their range within the next 40 to 75 years if current trends in sea ice reduction continue (73 FR 28212 [15 May 2008]). Nonetheless, impacts to bears as a direct result of oil and gas development activities appear to be minimal.

Effects from Natural Gas Development

The construction of new infrastructure in polar bear habitat has the potential to adversely impact these animals through disturbance and displacement. The offshore gas pipeline would require a relatively narrow corridor through designated polar bear Critical Habitat. Once installed, the pipeline would be under sea ice habitat for most of the year. The offshore pipeline would be installed during the open water season and would be buried in the seafloor. Vessel traffic associated with natural gas 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 where vessels are more likely to travel. As explained in the BO (USDOI, FWS, 2009), "During the open-water season, most polar bears remain offshore on the pack ice. Barges and vessels transporting materials for construction and on-going operations of facilities usually travel in open-water and avoid large ice floes. Therefore, there is some spatial separation between vessels and polar bears." If there is an encounter between a vessel and a bear, it would most likely result in short-term behavioral disturbance only. Polar bear responses to vessels are brief, and generally include walking toward, stopping and watching, and walking/swimming away from the vessel.

Extensive or repeated overflights by helicopters travelling to and from offshore facilities could disturb polar bears. Polar bears have been known to run from other sources of noise and the sight of aircraft, especially helicopters. According to the BO (USDOI, FWS, 2009), "Behavioral reactions of polar bears would likely be limited to short-term changes in behavior and have no long-term impact on individuals. In addition, [BOEMRE] requires these types of flights to operate at an altitude of >1,500 ft above ground level where possible, which would significantly reduce disturbance." It is expected that flight altitude requirements will minimize disturbances, and that adverse impacts from this activity will be temporary and minimal.

Pipeline construction could cross barrier island and nearshore coastal habitats. Polar bears may be temporarily displaced, or their behavior modified (e.g., by changing direction or speed of travel), by construction activities. As explained in the BO (USDOI, FWS, 2009), "Disturbance from stationary activities could elicit several different responses in polar bears. Noise may act as a deterrent to bears entering the area, or conversely, it could attract bears. Bears attracted to development facilities may result in human–bear encounters, leading to unintentional harassment, or intentional hazing of the bear." Mitigation measures (such as implementation of a human-bear conflict management plan) generally required under MMPA Incidental Take Authorizations (typically a Letter of Authorization) would reduce the potential for these impacts. Any adverse impacts would be localized and negligible.

Under the Final Rule designating Critical Habitat for polar bears, terrestrial denning habitat (Critical Habitat Unit 2) was not designated along the U.S. Chukchi Sea coastline (75 FR 76086 [Dec. 7, 2010]). In the Bering and Chukchi seas, the majority of dens that have been documented occur on

Wrangel and Herald islands, and on the Chukotka Peninsula in Russia. In recent years, sea ice formation along the coastline is occurring later in winter, which may preclude access to coastal denning areas along the U. S. Chukchi Sea coastline. While the FWS has determined that the coastlines of the Chukchi and Bering seas are not critical habitat, some dens may occur along the coast. Disturbance at den sites from construction or other human activities could result in a female with cubs abandoning the den site, resulting in death from hypothermia or predation to the cubs. Should construction activities be proposed near an active den, mitigation measures (such as den detection and avoidance) generally required under the Letter of Authorization would reduce the potential for these impacts. The raised onshore pipeline would not pose a physical barrier to polar bear movement, and once away from the coast, would not be in polar bear habitat.

Impacts from overland vehicles such as snowmachines would not result in more than temporary disturbance and energy expenditures for bears.

Effects from Natural Gas Production

Natural gas production activities would also risk disturbing polar bears. Potential sources of disturbance may be grouped as stationary sources (in this case including operations, maintenance, and repair activities) and mobile sources (e.g. vessels, aircraft, and vehicle traffic). Natural gas production will require the support of vessels, aircraft, and overland vehicles with similar, but less frequent effects, described for development activities.

Data and experience from past and ongoing activities in other portions of northern Alaska suggest that polar bears will habituate to or simply avoid gas production operations. The greatest risk to the polar bears from ongoing operations is the likely increase in human/polar bear interactions, which could be dangerous to both parties. In recent years, much progress has been made in reducing and managing these risks. The MMPA ITR provides clear guidance to the oil and gas industry and has been very effective at preventing injury to both humans and polar bears. Under the MMPA, since 1991, the oil and gas industry in Alaska has sought and obtained incidental take authorization for the take of small numbers of polar bears and no polar bears have been killed due to encounters with the current industry activities on the North Slope of Alaska (73 FR 28212, [15 May 2008]). Documented direct impacts on polar bears by the oil and gas industry operations during the past 30 years are minimal.

As previously noted, there is a small potential that a large gas release could occur from a platform, pipeline, or onshore facility. Impacts to polar bears would be minimal since gas quickly dissipates in the atmosphere. Potential impacts could result from a bear in the immediate vicinity inhaling gases; however, this is highly unlikely. Breathing holes visited by polar bears provide for rapid venting of methane to the atmosphere and pose little risk to the species. Impacts to polar bear critical habitat would occur only if an explosion resulted from the release, and these would be very short term.

Conclusions

Various aspects of the natural gas development and production scenario have the potential to disturb polar bears, but most impacts would be temporary and non-lethal, and would not rise to the level of significance. Pursuant to Section 7 of the ESA, BOEMRE has already consulted with FWS regarding potential impacts to polar bears from activities that would be authorized under a lease sale, as well as impacts from a certain degree of exploration activity. BOEMRE has reinitiated consultation in light of the recent designation of polar bear Critical Habitat. Additional consultation would also be required before BOEMRE would approve any Development and Production Plans. The ESA and MMPA contain general prohibitions of the unauthorized take of polar bears. OCS operators who acquire and adhere to an Incidental Take Authorization (ITA) can avoid liability for incidental take under the MMPA. The ITA process would identify and require any additional, site-specific mitigation deemed necessary by FWS to preclude the take from causing more than a negligible impact to the polar bear population. Current regulations provide that compliance with the terms and conditions of an MMPA ITA insures that the ITA holder is also in compliance with the ESA (see final special rule published at 73 FR 76249 [December 16, 2008]). Impacts to polar bears from natural gas development and production are expected to be similar to those identified in the Sale 193 FEIS for oil development and production. As discussed in the Sale 193 FEIS, the coastal deferrals (Alternative III and Alternative IV) provide increased protection for polar bear.

IV.C.8. Marine and Coastal Birds – Threatened and Endangered

Potential impacts to Threatened and Endangered marine and coastal birds in the Chukchi Sea area have been the subject of two recent Biological Opinions, which identified habitat loss, disturbance, and displacement as potential causes of adverse impacts relevant to this natural gas development and production scenario. The results of FWS analyses are used to inform much of the discussion below.

Effects from Natural Gas Development

In regard to development-related issues, FWS explains that “Given the large size of the Program Areas, significant impacts from permanent habitat loss in the marine environment are not anticipated. However, if facilities are located within the LBCHU, spring leads, or other areas used by large numbers or a high proportion of the populations of listed and candidate species, adverse effects could occur” (USDOI, FWS, 2009).

The impacts of terrestrial development, meanwhile, are highly dependent on the specific areas being disturbed. Particularly vulnerable to disturbance are nesting birds, which may flush, leaving eggs or ducklings exposed; displacement during nesting times can lead to reduced foraging efficiency and higher energetic costs. A pipeline for gas delivery is expected to be placed along a future oil pipeline, with approximately another 10 m wide fill footprint. Additional facility footprints in listed eider habitats were not considered necessary. The road/pipeline corridor was assumed to be 482.8 km (300 miles) long. Consequently, indirect nesting habitat impacts from a gas pipeline construction are estimated to affect 4.83 km^2 (1193.8 ac). Consistent with previous calculations which used nesting densities of 1.1 nests/km^2 for spectacled eiders and 0.06 nests/km^2 for Steller’s eider, an estimated take of 5.3 spectacled eiders and <1 Steller’s eider could occur during construction of a gas pipeline.

It is possible that development infrastructure could attract predators such as Arctic foxes, leading to negative impacts to marine and coastal birds. Such impacts, however, are unlikely. Natural gas development is not expected to affect bird predator populations (birds and foxes) as changes in the shorebase to accommodate gas would be made in such a manner that it would not provide nesting or denning sites for these predators. Further, the addition of a gas pipeline between the shorebase and the TAPS would be adjacent to an existing oil pipeline/maintenance road, so other birds and foxes would not benefit from additional sources of human-use foods or garbage, as no new facilities with dumpsters or dumpsites are needed. These food sources could continue to be a problem in coastal villages, however.

Effects from Natural Gas Production

As with the small amounts of natural gas periodically flared during oil production operations, the release and flaring of 10 million ft^3 of natural gas during a one day loss of gas well control would affect few birds in the immediate vicinity. Some migrating birds may become disoriented by the flare, especially during periods of darkness or inclement weather and could increase their potential for colliding with the platform structure. As collisions with structures in the Chukchi and Beaufort seas are typically low, the effects on non-listed bird species would be minimal; however, any collision mortality of spectacled or Steller’s eiders would be considered a significant adverse effect if these bird losses were not recovered within a generation. No adverse effects on coastal and marine birds are anticipated from a sudden release of natural gas from a pipeline rupture because the gas would typically dissipate into the atmosphere instead of lingering in a localized area where birds could be present.

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

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

Generally speaking, deferral areas could help reduce impacts by moving activities farther from coastal areas that typically exhibit greater bird use.

Conclusions

The natural gas development and production scenario analyzed in this Final SEIS comprises activities that are very similar or even identical to those analyzed in the preceding Sale 193 FEIS, and does not include some of the higher-risk activities (i.e. seismic surveying and exploration, platform construction, oil production). Therefore, one can expect natural gas-related impacts to be a continuation of the potential adverse environmental impacts associated with the oil development and production activities analyzed in the Sale 193 FEIS.

The Sale 193 FEIS, as well as each Biological Opinion, found notable potential for adverse impacts to Threatened and Endangered marine and coastal birds, but also explained that many of these potential impacts could be avoided or mitigated. It is reasonable to presume that through development of additional, site-specific mitigation measures during later environmental review processes, the new activities associated with the gas scenario (namely installing and operating an offshore gas pipeline, expanding an onshore facility, and installing and operating an onshore gas pipeline though NPR-A), would produce only minor impacts to Threatened and Endangered marine and coastal birds. No significant impacts are expected from any potential releases of natural gas. If high numbers of Threatened or Endangered birds from declining populations experience collisions and mortality as a result of extending the life of the platform and other facilities, this would constitute significant adverse effects. There are no differences in the level of adverse effect between the different sale alternatives because the location of the gas pipeline would be the same for each alternative and the offshore location of the gas facility would not change. Additional discussion on the types of impacts that could affect marine and coastal birds is provided in the section below.

IV.C.9. Marine and Coastal Birds

Marine and coastal birds could be exposed to a variety of potential negative effects during development and production of natural gas. Relevant sources of potential impacts include collision, habitat loss, and general disturbance. Sources of potential disturbance include heavy equipment, vessels, and support aircraft used during modification and operation of the production platform and shore facility, as well as the installation of offshore and onshore gas pipelines. As will be explained, the level of potential impacts depends to a great extent on the specific location and timeframe of these activities. In general, species with a relatively higher potential for substantial effects include murres, puffins, short-tailed shearwaters and auklets, black guillemot, loons, long-tailed duck, common eider, king eider, black-legged kittiwake, Pacific brant, phalaropes, and lesser snow goose.

Effects from Natural Gas Development

Migrating birds may be directly impacted through collisions, vessel strikes, and aircraft strikes. Collisions with manmade structures are often associated with weather conditions that cause poor visibility and/or magnify the lighting system of man-made structures. Often, artificial lights can attract disoriented birds, which may collide with the light support structure (e.g., pole, tower, or vessel). Mitigation measures pertaining to the array and use of lighting systems on vessels and platforms should reduce the potential for such impacts, which is expected to remain minor. Marine and coastal birds could also be directly impacted by aircraft strikes. However, these events are relatively rare, and would also be further reduced by mitigation required by future environmental review.

Although the natural gas development scenario entails expansion of the onshore facility and construction of offshore and onshore gas pipelines, it is unlikely that these activities would notably reduce marine and coastal bird habitat. The projected footprints of these facilities would be relatively small in terms of regional habitat availability. Also, it is anticipated that particularly important areas would be avoided through future, site-specific environmental review processes.

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). The vessels which would support natural gas development activities would not create noise or other forms of disturbance intense enough to have a significant impact on marine and coastal birds. Though installation of the pipelines could entail relatively large-scale activity in a small portion of the coastal environment, these impacts would be reduced through future environmental review processes related to project siting, and would in any event be temporary in nature. 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 broods could also result in the separation of adults and young, with similar consequences. Implementation of mitigation measures, such as minimum flight altitude requirements, would reduce the magnitude and frequency of aircraft related noise disturbances to coastal and marine birds. Overall, impacts from disturbance are somewhat likely, but would not be considered significant.

Natural gas development would not affect bird predator populations (birds and foxes) as changes in the shorebase to accommodate gas would not be made in such a manner that would provide nesting or denning sites for these predators. The addition of a gas pipeline between the shorebase and the TAPS would be adjacent to an existing oil pipeline/maintenance road, so other birds and foxes would not benefit from additional sources of human-use foods or garbage as no new facilities with dumpsters or dumpsites are needed. These food sources could continue to be a problem in coastal villages, however.

Effects from Natural Gas Production

Natural gas production would simply lengthen the window of time within which marine and coastal birds could be subjected to collisions and noise. These types of impacts are analyzed in the Development section directly above. Of course, vessel and aircraft traffic would be less frequent during the production phase than during certain portions of development, further reducing adverse impacts.

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

No additional types of impacts are anticipated during natural gas production.

Conclusions

As marine and coastal bird presence is quite variable by season and location, an accurate assessment of impacts at this early stage is difficult. Additional NEPA and other environmental review processes occurring at later stages of the OCS Lands Act program (i.e., exploration, development, and production) will have site-specific plans to focus an analysis. Significant adverse impacts to marine and coastal birds would be avoided and mitigated through restriction and measures implemented during those later review processes. There are no differences in the level of adverse effect between the different sale alternatives because the location of the gas pipeline would be the same for each alternative and the offshore location of the gas facility would not change.

IV.C.10. Other Marine Mammals

The main area of concern regarding the effects of industrial development on marine mammals is the potential for disturbance caused by industrial noise in the air and water, as discussed in Section IV.C.6.

Effects from Natural Gas Development

The natural gas development scenario would entail several sources of noise that could impact marine mammals, including small modifications to the platform and related infrastructure, installation of a new offshore gas pipeline, and a temporary increase in vessel and air traffic. Potential impacts will be considered for each group of marine mammals that could be present within the action area. Each of the following species is protected under the MMPA, and additional mitigation measures may be applied through subsequent regulatory processes.

Phocids (Ringed, Spotted, Ribbon, and Bearded Seals)

The effects of air traffic on pinnipeds in the action area are expected to be localized and transient. Some seals may be disturbed on the ice or at haulouts on land and enter the water, although their responses may be highly variable and brief in nature (Born, Riget, Dietz, et al., 1999; Boveng, Bengtson, Buckley et al., 2008, 2009; Burns and Harbo, 1972; Cameron, Bengston, Boveng et al., 2010; Kelly, Bengston, Boveng et al., 2010). Mitigation measures prohibiting aircraft overflights below 1,500 ft will lessen aircraft impacts to these pinnipeds. Results from studies of an existing facility (specifically, the Northstar development) are roughly analogous to what is contemplated under the present natural gas development scenario and suggest that any adverse impacts to phocids would be minor, short-term, and localized, with no measurable consequences to seal populations.

Pacific Walrus

Walrus are particularly vulnerable to disturbance events given their tendency to aggregate in large groups. Reactions to disturbances when on ice are highly variable (Richardson et al., 1995a). Reactions at group haulouts (on land) are more consistent; walrus will flee haulout locations in response to disturbance from aircraft and ship traffic, though walrus in the water are thought to be more tolerant. Females with dependent young are considered the least tolerant of disturbances. Walrus are particularly sensitive to helicopters and changes in engine noise, and are more likely to stampede when aircraft turn or bank overhead. 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. But while adverse impacts can be severe, they are also to a large extent avoidable. The FWS has concluded that a minimum altitude of 1000 ft above sea level (ASL) is sufficient in sea ice habitats (see p. 24 of the FWS Chukchi Sea EA, 2008) with a 1/2 mile (800m) horizontal buffer. BOEMRE has taken the more precautionary approach of a 1 mile horizontal buffer and 1500 ft above ground level (AGL) or ASL based in part on industry data and on unpublished ADFG and FWS haulout monitoring data (see ITL No. 2 in the Sale 193 FEIS). While BOEMRE does not regulate air space within the project area, direct overflights of terrestrial or sea ice walrus haulouts by industry are strongly discouraged. Typical mitigation measures include flight corridors, a minimum of one to two miles inland and directly from shore to the exploration site, while maintaining a minimum of one horizontal mile from groups of walrus hauled out on ice or land.

Overall, the potential for serious adverse impacts to individuals or groups of walrus do exist, but the probability is minimal in light of mitigation techniques, such as minimum altitude requirements for aircraft. Impacts to walrus are expected to be minor as a result of natural gas development.

Cetaceans

Potential effects to gray whale, minke whale, beluga whale, killer whale, and harbor porpoise are analyzed in this subsection. From a behavioral perspective, increased anthropogenic noise that would result from natural gas development activities 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; National Research Council, 2003a, 2005a). Toothed whales can be particularly sensitive to high-frequency sounds given their use of high-frequency sound pulses in echolocation, and moderately high-frequency calls for communication. Baleen whales, a group including gray and minke whales, are similarly sensitive to the low frequency noise that is often characteristic of construction, machinery operation, vessel noise, and aircraft noise. Any activity causing noise reaching 160 re 1 µPa would risk level B "harassment" take of whales, and require a take authorization under the MMPA. Additional mitigation measures required to avoid significant adverse impacts would be required by later BOEMRE and NMFS review processes. Detailed analysis of potential Exploration Plans and Development & Production Plans, along with mitigation measures incorporated into any necessary Incidental Take Authorizations (ITA), would further reduce the potential for any significant adverse impacts. Overall, while natural gas development activities may impact whales through masking and avoidance, significant impacts are not expected.

Effects from Natural Gas Production

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. Data from the Northstar facility indicates that underwater noise from vessels was detectable as far as 30 km offshore, and that noise from normal production activities reached background values at 2-4 km. Impacts from vessels are analyzed in greater detail above, within the section regarding development activities. Vessel traffic during the production phase will be comparatively infrequent, and therefore represents a reduced potential for adverse impacts. Non-vessel noise associated with production would only be problematic if it deflected cetacean migration. Such deflection would be highly localized and affect only a portion of the whales migrating through the Chukchi Sea. No population-level effects are anticipated.

The potential impacts of a large gas release could occur from a platform, pipeline, or onshore facility. Cetaceans are not likely to congregate in the vicinity of a platform or an onshore facility. In the event of a rupture in a sub-sea pipeline, impacts to marine mammals would be minimal since gas quickly dissipates in the atmosphere. Potential impacts could result if animals in the immediate vicinity were to inhale gases; however this is highly unlikely. Breathing holes visited by ice seals provide for rapid venting of methane to the atmosphere and pose little risk to these species. It is possible that, given a methane release, some ice ring natal dens immediately above a breathing hole could temporarily concentrate escaping methane before it could vent through the snow roof of such dens.

Conclusions

While the complexity of how marine mammal species react to underwater and above water sound make an exact determination of potential adverse impacts difficult, abundant regulatory review and careful design of mitigation measures are expected to preclude instances of level A, or “harm” take of marine mammals, and to reduce the potential for level B, or “harassment” take. No population-level impacts are anticipated as a result of natural gas development and/or production. By increasing the minimum distance of the platform from shore, the coastal deferral corridors could increase the distance that support vessel and aircraft routes must travel, as well as lengthen the offshore gas pipeline. However, pushing development further offshore would decrease the overall potential for natural gas development and production to impact marine mammals, particularly in spring when the coastal lead system is so very important.

IV.C.11. Terrestrial Mammals

Among the terrestrial mammal populations that could be affected by development activities for gas production in the Sale 193 area are caribou of the Central Arctic (CAH), Western Arctic (WAH), and Teshekpuk Lake (TLH) herds; muskoxen; grizzly bears; and Arctic foxes. The primary potential effects 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) for gravel pads for onshore facilities. These effects would be the same across all action alternatives.

The effects of 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).

Effects from Natural Gas Development

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.

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). However, these documented reactions of caribou were from aircraft that circled and repeatedly flew over caribou groups.

Gravel mining would alter a small area of river habitat along rivers but is not expected to disturb many caribou. Most caribou migrate south of the project area during the winter months when gravel will be mined, but small bands may be present.

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, 2006a). Pipelines without adjacent roads and vehicle traffic are not likely to affect caribou movements.

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, avoidance is not absolute and caribou may habituate to infrastructure and human activity (Haskell et al., 2006).

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). 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).

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. Minimizing traffic, especially within calving areas during the calving period, would reduce the potential for negative impacts on caribou.

The construction of roads and gravel pads 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, parasites, and new diseases could be introduced into the Arctic environment (Kutz et al., 2004; Urban, 2006).

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). Cronin, Whitlaw, and Ballard (2000) maintain that effects from onshore development and production 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 (Lenart, 2007; State of Alaska, 2009).

These findings suggest that caribou are largely able to habituate and adapt to oil field infrastructure. No significant impacts to caribou herds on the North Slope as a result of the gas development in the Sale 193 area are expected.

Muskoxen

Potential effects of development activities include direct habitat loss from gravel mining in river floodplains, and indirect habitat loss through reduced access caused by physical or behavioral barriers created by roads, pipelines, and other facilities (Clough et al., 1987 cited in 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 development than caribou, because they tend to remain year-round in the same habitat area (Jingfors, 1982); therefore, muskoxen may be more likely to habituate because of this year-round exposure.

Muskoxen 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 become accustomed 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).

No significant impacts to muskoxen on the North Slope as a result of the gas development in the Sale 193 area are expected.

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.

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 structures (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 may habituate to human noise and presence, leading to an increase in encounters. 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).

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. 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 activity could disturb and displace a few bears from den sites. Implementing the guidelines in the MMS publication *Guidelines for Oil and Gas Operations on Polar Bear Habitats* could reduce the chances of adverse grizzly bear-human interactions that may lead to the injury or loss of people and bears.

Arctic Fox

Development infrastructure can increase the availability of food and shelter for Arctic fox. Facilities provide additional food sources for foxes at dumpster sites near the galley and dining halls and at dumpsites (Eberhardt et al., 1982; Rodrigues, Pollard, and Skoog, 1994). Crawlspaces under housing, culverts, and pipes provide foxes with shelter for resting and, in some cases, artificial dens (Eberhardt et al., 1982; Burgess and Banyas, 1993).

Oil development on the North Slope 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). 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 development may adversely affect some fox-prey species (such as ground-nesting birds) in the area of infrastructure (Burgess et al., 1993).

Also helping to reduce potential disturbance of each of the above species, BOEMRE distributes an *Information to Lessees* regarding Bird and Mammal Protection. This document recommends air- and vessel-traffic distances to avoid disturbance of bird ands marine mammals that generally use many of the same coastal habitats as these terrestrial mammals. The ITL serves to alert industry to the potential effects of air and vessel traffic and to recommend measures to reduce those effects. As a result of their habitat similarities to birds and marine mammals, the ITL also is expected to reduce noise and disturbance effects of air and vessel traffic on caribou, muskoxen, grizzly bears, and Arctic foxes.

Effects from Natural Gas Production

Caribou and muskoxen would be periodically exposed to disturbances from road and air traffic related to maintenance of the gas pipeline across NPR-A. These effects are expected to be temporary and negligible at the population level. The small potential for a large natural gas release is also of little concern. The distance between any of the sale areas and the coast is such that it is extremely unlikely that natural gas released in offshore areas could contact the coast (or the terrestrial mammals on the coast). Also, natural gas will weather and dissipate quickly in the Beaufort or Chukchi, preventing widespread issues. Overall, the effects from a natural gas blowout or any other accident should be much lower than that which would be expected for a similar crude oil accident.

Conclusions

It is likely that several species of terrestrial mammals would be temporarily disturbed by natural gas development, and to a lesser extent, natural gas production activities. Negative impacts of this type can be difficult to quantify. However, existing data and anecdotal evidence strongly suggest that no species of terrestrial mammal would suffer significant adverse impacts under any action alternative.

IV.C.12. Vegetation and Wetlands

Foreseeable adverse impacts on terrestrial vegetation communities would be caused by the expansion of the shore-base facility, construction of the gas pipeline across NPR-A, gravel quarrying, and continued use of the gravel road along the pipeline corridor across NPR-A under all the action alternatives. Disturbances could include loss of tundra vegetation acreage, damage or destruction of vegetation cover, shift in plant species composition, and introduction of noxious weeds.

Effects from Natural Gas Development

The expansion of the shorebase facilities to support natural gas production would have minor impacts on some of the plant communities. These impacts would be localized and could include loss of tundra acreage, damage or loss of vegetation cover, shift in species composition, and introduction of noxious weeds.

Impacts would result from the 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 would also be expected from the construction of both the pipeline system and the shore-base facility.

Tundra vegetation cover would be removed permanently in areas where gravel pits are established. 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. Permanent gravel roads and pads would have direct impacts on plant communities. As they would greatly differ from adjacent substrates, gravel pads would comprise a set of completely different plant species if colonized. Most changes in plant communities around gravels pads and gravel roads would occur within about 50 m of the structure. 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 (National Research Council, 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 for plant communities. Warmed soils enhance nutrient availability leading to increases in annual primary production and a shift toward graminoid-dominated communities characterized by low plant species diversity.

Roadside dust produced on 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). Mosses are a large component of the vegetation of the western 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 (National Research Council, 2003b) in roads designed to be permanent.

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* sp. and *Tomentypnum nitens*, and all lichens are also 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 (National Research Council, 2003b).

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 freeezes (National Research Council, 2003b).

Reasonably foreseeable impacts on wetlands and terrestrial vegetation communities would be localized and would not adversely affect the functions of wetland ecosystems at a regional scale. These impacts would be moderate to significant at a local scale, 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. 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.

Standard operating practices for operating on the North Slope are expected to be implemented on a site-specific basis. These practices, which are discussed in Section IV.B.10 of the Sale 193 FEIS, are expected to protect tundra vegetation and wetlands from direct impacts to the greatest extent practicable. Notable standard practices include extracting gravel during winter months, using ice roads and ice pads for transport and construction activities, and building gravel pads to a thickness over 1.8 meters and potentially placing polyethylene insulation under the pad itself to protect against thawing of permafrost.

Effects from Natural Gas Production

Loss of vegetation, specifically of mosses and lichens typically found on acidic tundra, could occur from roadside dust related to maintenance of the gas pipeline across NPR-A. Discharges that could occur during production of natural gas 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 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).

Conclusions

Given the unique sensitivity of the tundra ecosystem in the region analyzed, some potential impacts to vegetation associated with natural gas development and production may be long lasting (e.g. disruption of slow-recovering vegetation communities) or even permanent (e.g. thermokarst). These impacts would, however, be highly localized and insignificant on a regional scale for all action alternatives.

IV.C.13. Economy

Natural gas development and production would generate economic activity manifested primarily in employment, personal income, and revenues to the local, State, and Federal governments. Economic effects would occur in the North Slope Borough (NSB), the rest of Alaska, and the rest of the U.S. A resident in Wainwright discusses what increased revenues could mean for his community:

> And when you go out hunting…we go buy bullets, and they are almost $30 a box now for a box of bullets…about $300 to go get gas, to burn gas. And on top of that, you got to go to the store and go purchase some food. That will probably be another $300…And by the time you are going out to gather our local food…and you are going to try to put something…on the table to eat, and it hurts sometimes when you have to try to go to hunt and you have to put almost $1,000 to go to hunt on one trip…because cost of produce and goods and the stuff we use to motorize our boats and stuff like that, snowmachines, Hondas…I start thinking as the mayor, boy, if we …if it benefit the federal, if it benefit that State and if it benefit the private sectors and it benefit a little local government, how much it would be – how much it would it would help us here…how much easier it would be for us in our community in subsidizing what we use to heat our homes and motorize our boats and going hunting out there. (Mr. Enoch Oktalik, Mayor, Wainwright, Alaska, June 30, 2011)

The exploration and development scenario in Section IV.A is the basis for analyzing potential economic effects in this section. The reader should refer to that section for timing of OCS activity. The activities, construction, and operation of infrastructure described in the gas development and production scenario generate economic activity. The resulting increases in employment and personal income would occur in two distinct phases: development and production. In general, employment numbers and associated personal income peak during development, then drop to a plateau during the production phase as production rates decline.

Section IV.A.1 defines the significance threshold for economics as effects “that would cause important and sweeping changes in the economic well-being of residents in the area or region. Local employment is increased by 20% or more for at least 5 years” (p. 74). The term “local employment” here means workers that are permanent residents of the NSB, both Iñupiat and non-Iñupiat, and does not include North Slope oil-industry workers who commute to residences within or outside of Alaska. Revenues accruing to local, State, and Federal governments can also cause changes in economic well-being.

Effects from Natural Gas Development and Production

Natural gas development and production under Sale 193 would have a positive impact on fiscal components, such as employment, personal income, and revenues in the region. Under the significance criteria above, employment and personal income effects from natural gas activities would be insignificant. However, property tax revenues accruing to the NSB would be substantial.

Employment and Personal Income

Employment and personal income effects during the natural gas development phase are assumed to be similar to the effects described for oil development and production in Section IV.C.1.k. and Table IV.C-1 in the Sale 193 FEIS. Natural gas development would initially cause a small increase in employment and personal income when it commences circa 2030. Additional workers would be needed to modify, expand, and develop new infrastructure associated with gas production as oil production rates decline and operations shift toward natural gas development. This small increase from the additional man power required to expand and modify the existing shore base to support gas production would continue during the 10 year transition period of 2035-2044, where both oil and gas would be produced from the offshore platform, and then taper off in later years of production back to the levels provided in Table IV.C-1 in the Sale 193 FEIS. While a majority of the jobs directly related to the oil and gas industry may be filled by workers who are not residents of the NSB, most of the (indirect) infrastructure, government, and support jobs are expected to be taken by local residents.

The employment and personal income associated with gas development would be slightly less than the employment and personal income associated with oil development, since most of the infrastructure necessary for gas development and production (roads, facilities, etc.) will have already been built for oil production prior to gas development (which is projected to begin in 2030). Just as local employment and personal income effects would be insignificant from oil development described in the Sale 193 FEIS, local employment and personal income effects from gas development would continue to be insignificant under the significance threshold listed above.

Revenues

Natural gas development and production would generate property tax revenues for the NSB totaling approximately $90 million over the depreciable life of the shore based gas support facilities and overland pipeline. The onshore infrastructure will be completed in 2035 and be assessed coincident with projected declines in NSB property tax levels. The contribution from this new infrastructure to NSB property tax revenue could yield up to $27.75 million in year 2035, providing an increase in NSB property taxes of about 32% above the level of projected Borough revenues without natural gas development and production.

Gas development and production would generate increases in property tax revenues to the State of Alaska of up to $2.25 million, with a total of up to $7.3 million accruing to the State over the depreciable life of the infrastructure. Given the geographical location of the parcels to be leased, no royalties would flow to the State from gas production. The Federal government, however, would receive royalties from the projected gas production totaling approximately $2.7 billion over the life of the production profile.

Natural gas from Sale 193 leases will contribute to extending the useful life of a large capacity North Slope gas pipeline to outside markets.

Conclusions

Natural gas development and production under all action alternatives would result in a variety of beneficial economic impacts, namely employment, personal income, and revenues. Under the significance threshold listed above, employment and personal income effects would be insignificant. Natural gas development and production would generate a substantial increase in property tax revenues accruing to the NSB, an increase in property tax revenues for the State, an increase in royalties the Federal government receives from gas production, and would contribute to extending the useful life of a large capacity North Slope gas pipeline to outside markets.

IV.C.14. Subsistence-Harvest Patterns

While patterns of subsistence use are not yet fully quantified and are subject to annual variation, over thirty years of systematic study and incoporation of traditional knowledge from stakeholder communities permits BOEMRE to understand general patterns of use, conduct a thorough analysis of potential impacts, and thus facilitate a reasoned choice among alternatives.

Access to subsistence resources and subsistence hunting areas 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 aircraft and vessel traffic, support-base expansion; and pipeline construction and maintenance.

Effects from Natural Gas Development

The noise-producing activities are those most likely to produce disturbance effects on critical subsistence species that include bowhead and beluga whales, seals, fish, caribou, and birds. Noise disturbance would be associated with aircraft and vessel support of modifications to platform facilities, installation of a gas pipeline from the platform to shore, expansion of shore facilities, and construction of the gas pipeline across NPR-A.

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 (Richardson and Malme, 1993). Bowheads are not affected much by 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 (984 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 (Richardson and Malme, 1993). 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. 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 and pipeline construction activities, most likely would experience temporary (Richardson et al., 1995a), non-lethal effects.

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. There is evidence that belugas will accommodate or acclimate to a particular pattern of noise after extensive exposure, and such acclimation also could affect Iñupiat 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.

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.

Activities that occur during ice-minimum conditions in summer in the Chukchi Sea may come into direct contact with adult females and subadult walrus (Jay et al, 1996). Walrus will flee haulout locations in response to disturbance from aircraft and vessel traffic (Richardson et al., 1995a). Females with dependant young are considered most vulnerable to disturbances. If disturbances cause walrus to abandon preferred feeding areas or interferes with pup-rearing, resting, or other necessary life functions, then the walrus population could be negatively affected.

Aircraft- and vessel-noise and presence could displace birds from the local area. Little direct mortality is expected, but losses of eggs and young to predators when adults are displaced is likely to occur.

Vessel traffic during the open water season is not expected to cause impacts to polar bears, because they generally do not linger in open water. 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.

Aircraft traffic overhead of caribou and other terrestrial mammals (muskoxen, grizzly bears, and Arctic foxes) could cause localized disturbance to these animals and some short-term disruption to the harvest, but is not expected to cause caribou and other terrestrial mammals to become unavailable to subsistence hunters.

An extensive discussion on traditional knowledge about noise and disturbance effects on subsistence resources and harvest is provided in Section IV.C.1.l(1)(a)6) of the Sale 193 FEIS. Many Iñupiat whale hunters express a traditional belief that whales can detect sounds much farther than can be measured by scientific instruments. This traditional belief, supported by empirical observation, implies that whales can perceive sounds and changes in the environment that cannot be detected by hearing, as hearing is defined by science. One of the most serious concerns to North Slope Iñupiat 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. 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. Nuiqsut whaling captain Frank Long, Jr., stated that oil-industry activity offshore has affected not only whales but also seals and birds (Long, 1993). According to studies and public scoping comments, low-altitude helicopter and scientific survey flights divert caribou and other terrestrial subsistence species from air-transport corridors and survey transects. 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 (USDOI, BLM, 2004a, 2004b). 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.

Noise and disturbance from aircraft and vessel traffic would have localized and short-term effects, and could cause some disruption to the subsistence harvest but would not cause bowheads, belugas, seals, walrus, caribou and other terrestrial mammals, birds, or polar bears to become unavailable to subsistence hunters (Braund and Burnham, 1984; USDOI, MMS, 1987, 1990b, 1995, 1998b; USDOI, BLM, 2005).

Restrictions on aircraft altitudes and vessel speed, and prohibitions on approaching marine mammals are expected to lessen the effects of noise disturbance to these subsistence species, and thus mitigate effects on subsistence activities.

Onshore and offshore construction could displace key subsistence species such as bowhead and beluga whales, seals, walrus, caribou, waterfowl, fish, bears, wolves, and other furbearers. Consequently, subsistence hunters would travel farther, at greater costs and effort.

Offshore pipeline effects on subsistence resources and harvest 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. Noise, disturbance, and habitat alterations from offshore pipeline laying could have some adverse effects on marine mammals (USDOI, MMS, 1987, 1990b, 1998b, 2003a, 2003b; USDOI, BLM, 2005). 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. Scientific and local Native knowledge of the behavior of marine mammals and the nature of noise associated with offshore oil and gas activities suggest that intense noise causes startle, annoyance, and flight responses. Some whales could be displaced seaward by construction and noise disturbance. In terms of subsistence activities, this effect may be most adverse for construction noise during bowhead migration. Traditional Inupiat observation and experience affirms that whales are affected by noise at great distances and alter their swimming directions for long periods. Noise and disturbance and habitat alterations from offshore pipeline installation would have a short-term and local effect on the subsistence harvest of marine mammals (USDOI, MMS, 1987, 1990b, 1998, 2003a, 2006b; USDOI, BLM, 2005).

Depending on the construction season, the construction of an offshore pipeline could displace and/or disturb marine and coastal birds in a variety of pelagic, nearshore, and estuarine terrestrial habitats. The construction of a pipeline between a production platform and an onshore base could cross many important bird habitats. Activities that take place in summer could temporarily displace birds using areas near such sites for one season or less. Local disturbance of birds within about 1 km of construction activities would be short term, and would have a short-term and local effect on the subsistence harvest.

Construction activities related to expansion of the shore facilities would have disturbance effects on subsistence resources and the subsistence harvest specific to that area. If the shore facilities are in the vicinity of Wainwright, as assumed for this analysis, expansion of the facilities could disturb walrus in the vicinity of Peard Bay, a walrus harvest area preferred by Barrow and Wainwright residents.

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 expansion of the shore facilities and construction of a pipeline across NPR-A and would be most intense during the construction period, but would subside after construction is complete.

Onshore, nesting sites are scattered at low density on the Arctic Coastal Plain. Relatively few sites 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 (a 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.

A small number of polar bears located within a few kilometers of the offshore pipeline landfall, shorebase expansion, and onshore pipeline construction could be disturbed and displaced. The effect on the subsistence harvest would be short-term and localized.

It is expected that various Sale 193 lease stipulations (see II.C.1) would help reduce the potential for adverse impacts in the event that the sale is affirmed. Notable examples include Stipulation 2, which requires workers to be oriented regarding important local issues; Stipulation 4, which requires marine mammal monitoring; and Stipulation 5, which requires industry to coordinate with local leaders prior to engaging in activities that could affect subsistence-harvest patterns. It is also expected that the potential for adverse impacts to subsistence-harvest patterns is reduced through implementation of deferral areas. Moving activities such as platform construction and production, as well as vessel traffic, farther from coastal areas would reduce the potential for disturbing subsistence-harvest patterns. Alternative IV exhibits less potential than Alternative I for impacts to subsistence-harvest patterns, and Alternative III offers the greatest potential advantages in this area.

Effects from Natural Gas Production

During the natural gas production phase, after construction, effects on subsistence activities are expected to return to levels experienced during the oil production phase. Because gas processing would be accommodated by an expansion of the oil processing facility and the overland pipeline would be constructed along the same corridor as the oil pipeline, effects on subsistence resources and subsistence-harvest activities are expected to increase minimally, if at all, relative to the effects of development and production as analyzed in the Sale 193 FEIS.

Onshore oil-development impacts on the subsistence-harvest system similar to those observed from development at Prudhoe Bay could be expected. Prudhoe Bay development has restricted access to traditional hunting areas in the vicinity. Prudhoe Bay development has led to the alteration of subsistence use areas. 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.

Conclusions

Natural gas development has the potential to induce significant impact on subsistence harvest patterns to the communities most proximate to the development. The activities most likely to lead to impacts include the construction of the pipeline and the expansion of the on-shore facility that may disrupt subsistence activities for a full season or longer. These impacts may be limited due to the existing oil development structures and the subsistence harvest patterns may have already changed.

Natural gas production also the potential to induce significant impacts on subsistence harvest patterns to the communities most proximate to the development. This would be a continuation of the impacts from oil production through the disruption of subsistence activities through the displacement of hunters from subsistence use areas.

IV.C.15. Sociocultural Systems

While sociocultural systems in potentially affected communities are difficult to quantify, over thirty years of systematic study, as well as explanation from stakeholder communities, permits BOEMRE to conduct a thorough analysis of potential impacts and facilitate a resoned choice among alternatives.

In determining the intensity of the potential adverse effects from Sale 193 natural gas development and production to sociocultural systems, we look at the magnitude and duration of disruption. Potential effects on social organization could occur if Sale 193 natural gas development and production 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. Although Sale 193 natural gas development and production are expected to provide significant revenues to the NSB, substantive changes in local employment and income characteristics are not expected to occur (Section IV.C.13). Short-term increases in local employment may occur related to gas development activities. Historically such employment opportunities, particularly as they translate into Native employment, have been insignificant; this is expected to continue. Though Native employment in oil-related jobs on the North Slope is currently low, Native leaders continue to push for programs and processes with industry that encourage more Native hires. In particular, hiring and employment practices that value and facilitate continued participation in subsistence activities are encouraged by the NSB and local residents. Increased employment opportunities would provide some economic benefits.

Effects on cultural values could occur if Sale 193 natural gas development and production alter subsistence harvest, known archaeological or cultural sites, or cultural continuity. As indicated in

Section IV.C.14, Wainwright could experience disruption of subsistence activities for a substantial portion of a subsistence season or more. Otherwise, no resource or harvest area is likely to become unavailable or undesirable for use because of noise and disturbance, and no resource would experience overall population reductions from Sale 193 natural gas development and production. Adverse effects on archaeological or cultural resources are not expected to occur as a result of Sale 193 natural gas development and production (see IV.C.16).

Potential effects on institutional organization could occur if Sale 193 natural gas development and production affect how institutions are structured or how they function to provide services and foster community stability. Sale 193 gas production would represent a continuation of routine and maintenance activities related to operation of the platform, shorebase, and pipelines. Continuation of these activities is not expected to require any changes to community or Borough services. Local employment would stabilize population and density; it would also slow the rate of decline and increase the stability of the community in the short term.

Sale 193 natural gas development activities could cause noticeable disruption to local sociocultural systems. Wainwright (the community nearest the shorebase) may experience significant short-term effects. Noticeable disruption most likely would result during development from the expansion of onshore infrastructure. The effect of expansion of the shorebase, however, would be much less than the effect of the initial construction of the shorebase and the introduction of a new level of industrialization. While the initial construction of the shorebase would likely lead to a displacement of existing social patterns, those changes would have occurred prior to natural gas development and no further displacement of social patterns would be expected.

The shorebase would serve to house project-related workers, who would largely rotate through the area during shift changes. Sufficient housing is expected to be available to handle what influx may occur. Any influx of new residents from development and production related employment would be expected to have little direct and indirect consequences to local Inupiat sociocultural systems. The proximity of the shore base to Wainwright may bring non-resident workers at the shorebase facility and others into greater contact with local area residents. Positive and negative effects may result from this interaction.

Conclusions

The following conclusions may be drawn from the analyses:

- At the regional level (NSB), effects to sociocultural systems from Sale 193 natural gas development and production should not exceed the significance threshold.
- At the local level (Wainwright in the scenario), effects from Sale 193 natural gas development and production could exceed the significance threshold.
- Mitigation measures should prove effective in ameliorating many of the effects of Sale 193 natural gas development and production. Social systems are expected to successfully respond and adapt to the change brought about by the continuation of production activities. This accommodation response represents circumstances that should not exceed the significance threshold.

IV.C.16. Archaeological Resources

Effects from Natural Gas Development

Archaeological surveys and analyses are required in areas where potential archaeological resources are at risk from offshore operations. Under the National Historic Preservation Act (NHPA), consultation with the Alaska State Historic Preservation Office is required for any activities that may adversely affect archaeological resources or historic properties. Preconstruction surveys and additional mitigation measures, which may flow from the NHPA Section 106 process would largely preclude, or at least reduce, the potential for adverse impacts to these resources.

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. 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 (B.P.). 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. Physical disturbance of resources could damage or destroy shipwrecks or artifacts, or cause a loss of site context with resulting loss of archaeological data or artifacts. Activities related to gas development that have the potential to disturb offshore archaeological resources are anchoring and pipeline trenching.

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. Yet the potential is very small for a natural gas pipeline installed along the same corridor as a then-existing oil pipeline (for which archaeological clearance will have already been performed) to actually impact such resources. Comparing alternatives, there is a positive correlation between the size of the area deferred from leasing and potential impacts to archaeological resources, but the overall potential for impacts remains small under each action alternative.

Any onshore activity that removes or disturbs soil and/or causes shallow permafrost to thaw has the potential to disturb archaeological resources. Activities related to gas development that could damage previously unidentified onshore archaeological resources are expansion of shore facilities, construction of a gas pipeline across NPR-A, and gravel mining, particularly along the trend of paleo-riverbanks or buried over-bank deposits.

We assume that onshore pipelines would be elevated with vertical support members (pilings). These probably would disturb <2 ft^2 (0.2 m^2) 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.

In sum, preconstruction survey requirements, Section 106 consultation, and other mitigation measures would greatly reduce the potential for natural gas development activities to adversely affect archaeological resources. Ideally, BEOMRE would already possess complete information on the location and characteristics of all archaeological resources in the action area, as well as the location and nature of any development projects which may be proposed. This missing information, while clearly useful, is not considered essential for a reasoned choice among alternatives at the lease sale stage. After all, additional information on project plans would become known if and when proposals are submitted at later stages of OCS environmental review (see Figure 3 in Chapter 1 for an illustration of the four stages in the OCSLA process). Additional information on the location of archaeological resources would be gathered through required preconstruction surveys and utilized to avoid or minimize impacts during the Development & Production phase. Also, other environmental laws and regulation (i.e. pipeline protocols, Section 106 of the NHPA) would further reduce the potential for significant adverse impacts under each alternative. At this stage, the missing information is also not essential to choosing between the alternatives because it is clearly understood that lengthening the distance of the pipeline increases the chances of encountering these unknown locations, thus allowing the decision maker a reasoned choice among the alternatives.

Given applicable protocols and consultation processes, as well as anticipated mitigation measures, the overall potential for impacts to archaeological resources from natural gas development remains small under each alternative.

Effects from Natural Gas Production

Continued potential access to historic and prehistoric sites presents continuing potential for damage to these sites by human activities and possibly vandalism.

Conclusions

There is a small potential that certain natural gas development activities could cause irreversible adverse impacts to currently unknown archaeological resources. Such impacts could be significant. However, the potential for significant adverse impacts will be further reduced through adherence with standard pipeline construction protocols and measures identified during the NHPA Section 106 consultation process.

IV.C.17. Environmental Justice

Alaska Iñupiat Natives, a recognized minority, are the predominant residents of the NSB. There are no significant numbers of "other minorities" in potentially affected Iñupiat communities. Iñupiat Natives are the only minority population allowed to conduct subsistence hunts for marine mammals in the region (Figure 14). No "other minorities" are allowed to participate in subsistence marine mammal hunts and, therefore, would not constitute a potentially affected minority population (North Slope Borough, 1999). Because of the nearly homogeneous Iñupiat 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 Iñupiat are affected disproportionately.

Figure 14. View of specialized sleds used for different conditions in Point Hope yard (June 22, 2011).

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, 2010). The 2000 Census identifies no nonsubsistence-based coastal communities in the NSB with median household incomes that fall below the low income threshold.

“Significant” effects with respect to EJ are defined as: disproportionately high adverse impacts to low-income and minority populations. Coastal communities could experience impacts on subsistence resources and subsistence-hunting practices as a result of noise and disturbance from aircraft and vessel traffic; pipeline construction, shorebase expansion, and ice-road construction. Potential significant impacts to subsistence resources and harvests and consequent impacts to sociocultural systems could result in adverse EJ-related impacts. The potential effects of Sale 193 natural gas development and production would focus on the Iñupiat communities of the region.

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.

Sale 193 natural gas development and production could contribute to various ambient and ongoing localized and regional effects on social pathology (assault, alcohol and drug abuse, domestic violence, suicide, and homicide). The associated health outcomes would be expected to parallel sociocultural changes to some extent. The most important sources of impacts would include:

- Influx of temporary personnel into Iñupiat villages, leading to cultural conflicts and the potential for alcohol and drug importation.
- Stress, tension, and increased demands on individual time because of opposition to increasing potential on- and offshore development.
- Acculturation stress, secondary to influences and 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.

Injury rates could be affected by Sale 193 natural gas development and production through three pathways:

- Displacement of subsistence animals resulting in increasing the time and effort needed to harvest resources.
- More erratic and aggressive behavior of subsistence animals disturbed by gas development and production activities.
- 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 Sale 193 natural gas development and production will depend on the degree to which the potential impacts on sociocultural characteristics, subsistence, and drug and alcohol importation into the villages occur.

Overall air quality impacts of Sale 193 natural gas development and production are projected to be low, therefore the impact to human health from emissions related to gas development and production is expected to be low. Regional, seasonal, and local variations could occur, which could have potential effects on human health. These variations would be determined and mitigated on a site-specific basis at the time of consideration of the proposed siting of shorebase facilities.

Increased travel, the introduction of new populations, and the influx of visitors and temporary workers from outside the North Slope region related to Sale 193 natural gas development and production represents a potential source of infectious disease transmission, including sexually transmitted diseases, respiratory diseases, and other infections, to local residents.

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 on human health. Environmental contaminants may enter the human environment through airborne emissions (as discussed above), through consumption of contaminated vegetation, or through consumption of subsistence species that are contaminated or that have consumed contaminated prey or vegetation. As previously discussed, emissions related to Sale 193 natural gas development and production are expected to be within NAAQS standards, are not expected to adversely affect overall air quality of the Chukchi Sea Planning Area, or directly affect human health. Adverse effects on water quality from development activities are expected to be short term and localized. No discharges related to gas production are expected to occur. Therefore, absent an unforeseen accidental event, no health impacts from contaminated subsistence foods is expected as a result of Sale 193 natural gas development and production. It is possible that the deferral areas under Alternative IV and, to a greater extent, Alternative III could reduce the potential for adverse impacts by further removing any discharges, emissions, etc. from populated areas.

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).

Oil and gas development (both onshore and offshore) has become a dominant socioeconomic force on the North Slope. Direct and indirect influences of development are experienced through, for example, the influx of people from a different culture entering previously isolated Iñupiat villages; stress over perceived and actual threats to culture and subsistence; direct and indirect employment opportunities; and broad economic and infrastructure improvements. Effects on the SDH may create concomitant positive and negative effects on health status. For example, a local increase in employment may create benefits through economic opportunity and also 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. Effects on SDH from Sale 193 natural gas development and production would be greatest during development activities and then return to pre-gas development activities during the gas production phase.

Conclusions

The Alaska Iñupiat Natives are the only substantial “minority” group within the action area. Significant adverse impacts to the subsistence harvest patterns and sociocultural systems in the vicinity of development would constitute disproportionate high adverse impacts in terms of Environmental Justice.

IV.D. Very Large Oil Spill (VLOS)

The potential environmental effects of a low-probability, high impacts event—a hypothetical very large oil spill (VLOS) in the Chukchi Sea Program Area—are analyzed below. This VLOS analysis comprises two parts or sections: (1) the first part (Section IV.D) describes the hypothetical VLOS scenario by providing background and new information in light of the *Deepwater Horizon* (DWH) event and explaining the specific parameters that characterize the hypothetical VLOS; (2) the second part (Section IV.E) analyzes potential environmental impacts that could occur in the event of such a VLOS in the Chukchi Sea.

IV.D.1. Background

Background and context for this analysis is provided in light of the recent *Deepwater Horizon* (DWH) event and its ramifications for activities on the OCS, including the Chukchi Sea Planning Area.

The Deepwater Horizon Event

The *Deepwater Horizon* was a semi-submersible mobile offshore drilling unit operated by British Petroleum Exploration & Production, Inc. engaged in drilling the Macondo well on Mississippi Canyon Block 252 (MC252) in Outer Continental Shelf (OCS) waters located in the Gulf of Mexico, about 41 miles offshore of Louisiana.

On April 20, 2010, an explosion and fire occurred aboard the *Deepwater Horizon* while the vessel was in the process of plugging the well prior to temporary abandonment. The blowout resulted in the discharge of oil and gas in the Gulf of Mexico, the deaths of eleven men, and the injury of many others. Response teams were not able to control the fire and the vessel sank on April 22, 2010 in about 5,000 feet of water and came to rest approximately 1,500 feet from the subsea wellhead. Before the rig sank, response teams were not able to stop the flow of oil and gas from the well. All attempts to completely close the blowout preventer failed. An estimated 4.9 million barrels of oil and an unknown quantity of natural gas was released (until the well was capped on July 15, 2010). On August 19, 2010, four months after the initial event, a relief well was completed and the well was permanently plugged and abandoned.

BOEMRE and the U.S. Coast Guard (USCG) are conducting a joint investigation to identify the factors which led up to the event, and developing conclusions and recommendations for future procedural and/or policy changes. On April 22, 2011, the *Deepwater Horizon* Joint Investigation Team released a preliminary report covering issues under Coast Guard jurisdiction. A final report was still being developed when this document was written. The DWH event also precipitated several changes to BOEMRE's regulation of oil and gas activities on the OCS, which are addressed in the subsections below. This VLOS analysis assesses the relevance of the DWH event and its consequences to potential operations in the Chukchi Sea, and incorporates into the present decision-making process the lessons learned from that tragic event.

OCS Well Control Incident Rates

This section updates information in the Sale 193 FEIS Appendix A, Section A.1.c which discussed OCS well control incidents from 1971-2005. The year 1971 is considered reflective of the modern regulatory environment. The term "loss of well control" was first defined in the 2006 update to the incident reporting regulations (30 CFR 250.188). Prior to this 2006 update, the incident reporting regulations included the requirement to report all blowouts, and the term blowout was undefined. Three relevant data sets are considered: (1) all well control incidents from 1971-2009 prior to the DWH event to update the Sale 193 FEIS information baseline, then (2) well control incident rates from exploration and development drilling including the DWH event, and finally (3) spills associated with well control incidents from exploration drilling including the DWH event (USDOI, BOEMRE, AIB, 2011).

Exploratory and Development/Production Operations from 1971–2009. There were 249 well control incidents during exploratory and development /production operations on the OCS (this includes incidents associated with exploratory and development drilling, completion, workover, plug and abandon, and production operations). During this period, 41,514 wells were drilled on the OCS and 15.978 billion barrels (Bbbl) of oil were produced. Of the 249 well control incidents that occurred during this period, 50 (20%) resulted in the spillage of condensate/crude oil ranging from <1 bbl to 450 bbls. The total spilled from these 50 incidents was 1,829 bbls. This volume spilled was approximately 0.00001147% of the volume produced during this period.

In 2010, four well control incidents occurred, including the DWH event. Although a final spillage volume from the DWH event has not been determined by BOEMRE, the current estimate from Lubchenco et al. (2010) is 4.9 million bbls. The three other well control incidents that occurred in 2010 did not result in the spillage of condensate/crude oil.

Development and Exploration Well Drilling from 1971–2010. There were a total of 41,781 wells drilled in the OCS comprising 40,565 wells in the Gulf of Mexico, 1,086 wells in the Pacific OCS Region, 46 wells in the Atlantic OCS Region and 84 wells in the Alaska OCS Region. Of these, 26,245 were development wells, 15,491 were exploration wells and 43 were core tests or relief wells. The overall drilling well control incident rate is 1 well control incident per 292 wells drilled, compared to 1 well control incident per 410 development wells drilled, and 1 well control incident per 201 exploration wells drilled. These well control incident rates include all well control incidents related to drilling operations whether they spilled oil or not.

Exploration Well Drilling from 1971–2010. Industry has drilled 223 exploration wells in the Pacific OCS, 46 in the Atlantic OCS, 15,138 in the Gulf of Mexico OCS, and 84 in the Alaska OCS, for a total of 15,491 exploration wells. During this period, there were 77 well control incidents associated with exploration drilling. Of those 77 well control incidents, 14 (18%) resulted in oil spills ranging from 0.5 bbl to 200 bbls, for a total 354 bbls, excluding the estimated volume from the DWH event. From 1971-2010 one well control incident resulted in a spill volume of 1,000 bbls or more and that was the DWH event.

Government Reports and Recommendations

Since the DWH event, several entities within or commissioned by the Federal government have offered formal recommendations regarding review and regulation of OCS oil and gas activities.

Council on Environmental Quality (CEQ). As a direct result of the DWH event, the CEQ reviewed the MMS NEPA policies, practices and procedures relating to OCS oil and gas exploration and development and issued a report on August 16, 2010 (CEQ, 2010). This report recommended that MMS, since renamed BOEMRE, "ensure that NEPA documents provide decision makers with a robust analysis of reasonably foreseeable impacts, including an analysis of reasonably foreseeable impacts associated with low probability catastrophic spills for oil and gas activities on the Outer Continental Shelf." This report also asked BOEMRE to "Consider supplementing existing NEPA practices, procedures, and analyses to reflect changed assumptions and environmental conditions, due to circumstances surrounding the [Macondo] Oil Spill."

Consistent with CEQ recommendations, this section supplements existing NEPA analyses related to Lease Sale 193 by evaluating new information and analyzing potential environmental impacts of a VLOS, which is a low probability, high impact event.

National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. On January 11, 2011, the National Commission on the BP *Deepwater Horizon* Oil Spill and Offshore Drilling (Commission) issued its final report. This report described the causes of the DWH event and recommended reforms intended to make offshore energy production safer. The Commission also reviewed and made recommendations concerning oil spill prevention and response.

U.S. Coast Guard. BOEMRE and the USCG are conducting a joint investigation to identify the causes of the DWH event and any procedural or policy changes that could prevent such tragedies in the future. On April 22, 2011, the Deepwater Horizon Joint Investigation Team released a preliminary report covering issues under Coast Guard jurisdiction. The investigation continues into the *Deepwater Horizon's* blowout preventer issue and other issues under the jurisdiction of BOEMRE.

In response to the DWH event and informed by these subsequent reports, BOEMRE has undertaken rulemaking, issued NTLs and is currently conducting a review of categorical exclusion policies under NEPA.

Rule Changes Following the *Deepwater Horizon* Event

The aftermath of the DWH event provided new information about drilling on the OCS; in particular, it provided new information about (1) systemic safety issues, (2) deficiencies of blowout containment technologies and strategies, and (3) shortcomings in oil spill response strategies and resources relative to spills in deepwater. BOEMRE has addressed these issues by strengthening its regulations of OCS activities. Notable initiatives are discussed below. For additional discussion on advancements in safety and their meaning for OCS activities going forward, the reader is referred to an October 1, 2010 memorandum from the Director of BOEMRE to the Secretary, which supported lifting the suspension of certain offshore permitting and drilling activities on portions of the OCS (available at http://www.doi.gov/news/pressreleases/loader.cfm?csModule=security/getfile&PageID=64703).

New rules and rulemaking procedures, along with new and revised Notices to Lessees, are listed below. Further discussion of more notable developments is then provided.

- The Drilling Safety Rule, Interim Final Rule to Enhance Safety Measures for Energy Development on the Outer Continental Shelf (Drilling Safety Rule). This rule strengthens requirements for safety equipment, well control systems, and blowout prevention practices in offshore oil and gas regulations.
- The Workplace Safety Rule on Safety and Environmental Management Systems (SEMS Rule). This rule requires operators to develop and implement a comprehensive SEMS for identifying, addressing, and managing operational safety hazards and impacts; for promoting both human safety and environmental protection; and for improving workplace safety by reducing risk of human error.
- NTL 2010-N06, "Information Requirements for Exploration Plans, Development and Production Plans, and Development Operations Coordination Documents on the OCS," effective June 18, 2010 (Plans NTL).
- NTL-2010-N10, "Statement of Compliance with Applicable Regulations and Evaluation of Information Demonstrating Adequate Spill Response and Well Containment Resources," effective November 9, 2010 (Certification NTL).

The Drilling Safety Rule. On October 14, 2010, BOEMRE issued an interim final rule entitled "Increased Safety Measures for Energy Development on the Outer Continental Shelf" (75 FR 63346). The interim rulemaking revises selected sections of 30 CFR 250 Subparts D, E, F, O, and Q. The Drilling Safety Rule includes new standards and requirements related to the design of wells and testing of the integrity of wellbores, the use of drilling fluids, and the functionality and testing of well control equipment including blowout preventers. To these ends, the rule is expected to promulgate OCS-wide provisions that will:

- Establish new casing installation requirements
- Establish new cementing requirements
- Require independent third party verification of blind-shear ram capability

- Require independent third party verification of subsea BOP stack compatibility
- Require new casing and cementing integrity tests
- Establish new requirements for subsea secondary BOP intervention
- Require function testing for subsea secondary BOP intervention
- Require documentation for BOP inspections and maintenance
- Require a Registered Professional Engineer to certify casing and cementing requirements
- Establish new requirements for specific well control training to include deepwater operations

Safety and Environmental Management Systems Rule. A new subpart to 30 CFR Part 250: Subpart S – Safety and Environmental Management Systems (SEMS) is designed to reduce the hazards associated with drilling operations and further reduce the likelihood of a blowout scenario such as described for this VLOS analysis. The SEMS Rule requires all OCS operators to develop and implement a comprehensive management program for identifying, addressing, and managing operational safety hazards and impacts, with the goal of promoting both human safety and environmental protection. The interim final rule was published in the *Federal Register* on October 14, 2010 (75 FR 63345), requiring full implementation of a SEMS program by November 15, 2011. The 13 elements of the industry standard (American Petroleum Institute, Recommended Practice 75) that 30 CFR 250 Subpart S now makes mandatory are as follows:

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

NTL (Notice to Lessees) 2010-N06. Though not a rulemaking, a recent NTL issued by BOEMRE warrants discussion here. Effective November 8, 2010, NTL No. 2010-NO6 requires that blowout intervention information be submitted with future Exploration or Development and Production Plans. The blowout scenarios required by 30 CFR 250.213(g) and 250.243(h) provide a potential blowout of the proposed well expected to have the highest volume of hydrocarbons, and must include supporting information for any assertion that well bridging will constrain or terminate the flow or that surface intervention will stop the blowout. The availability of a rig to drill a relief well and rig package constraints must also be addressed. These scenarios must also specify as accurately as possible the time it would take to contract for a rig, move it on site, and drill a relief well, including the possibility of drilling a relief well from a neighboring platform or an onshore location.

NTL (Notice to Lessees) 2010-N10. Also released on November 8, 2010 was NTL 2010-N10. This NTL explains that applications for well permits must include a statement that all authorized activities will be conducted in compliance with all applicable regulations, to include the new measures discussed above. For operations using subsea BOPs or surface BOPs on floating facilities, BOEMRE will evaluate whether each operator has submitted adequate information demonstrating that it has access to and can deploy subsea containment resources that can adequately and promptly respond to a blowout or other loss of well control. BOEMRE will also evaluate whether each operator has adequately described the types and quantities of surface and subsea containment equipment that the operator can access in the event of a spill or threat of a spill.

Joint Industry Task Forces. In response to the DWH event, several entities within the oil and gas industry cooperatively formed Joint Industry Task Forces. The stated purpose of each Task Force is "to review and evaluate current capacities, and to develop and implement a strategy to address future needs and requirements in equipment, practices or industry standards" applicable to the studied activity. Where possible, information developed by these Tasks Forces will be augmented with input from regulatory agencies, oil spill response and well control specialists, investigation panels, and other public sector and non-governmental organizations. To date, Task Forces on "Oil Spill Preparedness and Response" and "Subsea Well Control and Containment" have submitted draft recommendations. Joint Industry Task Force recommendations will not have the force of regulation, but may provide the basis for enhanced industry standards or future rulemaking processes.

IV.D.2. Very Large Oil Spill (VLOS) Scenario

To facilitate analysis of the potential environmental impacts of a VLOS in the Chukchi Sea, it is first necessary to develop a VLOS scenario. Scenarios are conceptual views of the future and represent possible sets of activities. They serve as planning tools that make possible an objective and organized analysis of hypothetical events. This VLOS scenario is not to be confused with what would be expected to occur as a result of any of the action alternatives.

The VLOS scenario is sometimes confused with worst-case discharge (WCD) analyses, which are used to evaluate an Exploration Plan (EP) or Development and Production Plan (DPP). Both calculations are alike to the extent that they are performed by BOEMRE using similar assumptions and identical analytical methods. However, these calculations differ in several important ways (Table 2):

- **Very Large Oil Spill.** Rather than analyzing a specific drilling proposal, the VLOS model selected a prospect within an area that potentially maximizes the variables driving high flow rates. Therefore, the VLOS scenario represents an extreme case in flow rate and discharge period that, in turn, represents the largest discharge expected from any site in the subject area.
- **Worst-Case Discharge.** Site-specific WCDs at sites identified in a submitted plan in the subject area would typically result in much lower initial rates and aggregate discharges if discharge periods are held equal. The calculations also differ in their purpose. Whereas the VLOS scenario is a planning tool for NEPA environmental impacts analysis, a WCD is the calculation required by 30 CFR Part 250 to accompany an Exploration Plan or Development and Production Plan and provide a basis for an Oil Spill Response Plan.

The VLOS scenario is predicated on an unlikely event—a loss of well control during exploration drilling that leads to a long duration blowout and a resulting VLOS. Information on OCS well control incidents was addressed in Section IV.D.1. It is recognized that the frequency for a VLOS on the OCS from a well control incident is very low. From 1971-2010 there has been one very large oil spill during exploratory and development/production operations on 41,781 wells, or 2.39×10^{-5} per well.

Table 2. Comparison between a Very Large Oil Spill analysis and a Worst-Case Discharge analysis.

Characteristic	VLOS	WCD
Geographic Area of Focus	A broad area described by the Chukchi Sea Program Area	A specific location described by an Exploration Plan or Development and Production Plan.
Reason for Analysis	The VLOS scenario is hypothetical and is provided as a general planning tool for the entire Program Area.	A WCD always accompanies an industry EP or DPP for a specific site, and provides the basis for an Oil Spill Response Plan.
Regulatory Basis	A VLOS scenario serves to respond to CEQ regarding a low probability, high impact event	The WCD calculation is required by 30 CFR Part 250.
Estimated Flow Rate	Maximizes estimated flow rate to represent the largest potential discharge estimated from any site in the entire Program Area.	Maximizes estimated flow rate to represent the largest potential discharge from one actual (known) drilling location. This will typically mean lower aggregate discharges than a VLOS.

The low "geological" chance that the exploration well will successfully locate a large oil accumulation, coupled with the observed low incidence rates for accidental discharges in the course of actual drilling operations, predicts a very small, but not impossibly small, chance for the occurrence of a VLOS event. But this consideration of probability is not, nor should it be, integrated into the VLOS model. The VLOS discharge quantity is "conditioned" upon the assumption that all of the necessary chain of events required to create the VLOS actually occur (successful geology, operational failures, escaping confinement measures, reaching the marine environment, etc.). The VLOS discharge quantity is, therefore, not "risked" or reduced by the very low frequency for the occurrence of the event.

Rate, Time and Composition of Hypothetical Spill

The VLOS scenario assumes a blowout leading to a very large oil spill. In developing this scenario, BOEMRE first generated a hypothetical oil discharge model that estimates the highest possible uncontrolled flow rate that could occur from any known prospect in the proposed Sale 193 area, given real world constraints. The discharge model was constructed using a geologic model for a specific prospect in conjunction with a commercially-available computer program (AVALON/MERLIN) that forecasts the flow of fluids from the reservoir into the well, models the dynamics of multiphase (primarily oil and gas) flow up the wellbore, and assesses constraints on flow rate imposed by the open wellbore and shallower well casing. This model utilized information and selected variables that, individually and collectively, provided a maximized rate of flow. The most important variables for the discharge model included thickness, permeability, oil viscosity, gas content of oil, and reservoir pressure. Many other variables of lesser importance were also required.

Table 3 summarizes the results of the discharge model for the hypothetical well. The oil discharge climbs rapidly to over 61,000 bbls/day during Day 1. After peaking in Day 1, Figure 15 shows that the oil discharge (green boxes) declines rapidly through the first 40 days of flow as the reservoir is depressurized by approximately 1,400 psi (Table 3). The decline in the flow rate flattens somewhat after Day 40, falling to 20,479 bbls/day (33% of the Day 1 peak rate) by Day 74 when the near-wellbore reservoir pressure has fallen to 58% of the initial reservoir pressure (4,392 psi). The total oil discharge by the end of the flow period on Day 74 is 2,160,200 bbls.

The oil discharged from the hypothetical well is estimated to be 35° API crude oil like that recovered at the Klondike 1 well. This type of crude oil is believed to represent the dominant (Triassic-sourced) petroleum system in the central Chukchi Sea. The oil in the hypothetical reservoir is initially-saturated (with gas) at a gas-oil ratio of 930 cf/bbl (quantities at standard conditions of 60°F and 1 atm.) and this is reflected by the fact that the initial produced gas-oil ratio in the flow model (Day 0.1, see Table 3) is also 930 cf/bbl. As shown in Table 3, the produced gas-oil ratio falls to a minimum of 757 cf/bbl through the period from Day 15 to Day 27, as early production rates fall rapidly with de-pressurization of the reservoir near the wellbore. As a larger volume of the reservoir becomes de-

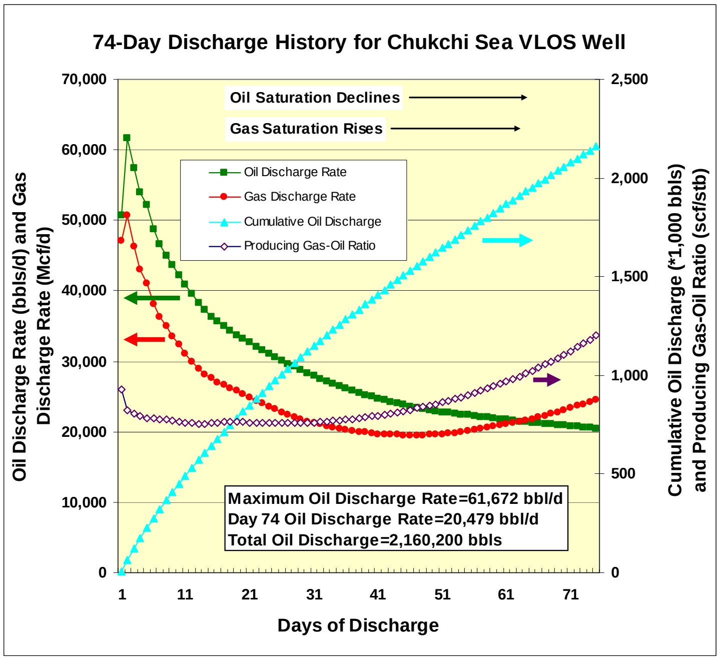

Figure 15. Decline in daily discharge rates and rising cumulative oil discharge for a 74-day period after a blowout at a hypothetical exploration well in the central Chukchi Sea planning area.

pressurized below the bubble-point pressure, gas dissociates in larger quantities from the oil within the reservoir, and the produced gas-oil ratio steadily rises to a maximum of 1,202 cf/bbl by the end of the flow period on Day 74. Water production over the flow period is quite small (as shown in Table 3) because of the higher relative permeability to oil within the oil-saturated reservoir and the assumed absence of a brine-saturated reservoir in contact with the wellbore. Further discussion of the AVALON/MERLIN model and the variables selected in estimating flow rate is provided in Appendix D.

Additional Parameters

The following discussion describes additional parameters of the VLOS scenario. These parameters are based on reasonably foreseeable factors related to oil spills, based on past VLOS events (i.e. the Exxon Valdez Oil Spill (EVOS), DWH event, and the Ixtoc oil spill), published scientific reports, consideration of Arctic-specific conditions, and application of best professional judgment. The result is a framework for identifying the most likely and most significant impacts of the hypothetical VLOS event. Key aspects of the scenario are listed below:

- A loss of well control during exploration drilling leads to a blowout and an ongoing, high volume release of crude oil and gas that continues for up to 39-74 days.
- Oil remains on the surface of the water for up to a few weeks after flow has stopped or after meltout from sea ice during the Arctic spring.
- The total volume of the oil is nearly 2.2 MMbbls (million barrels) and the volume of the gas is 1.8 Bcf (billion cubic feet)—within 74 days.
- Roughly 30 percent of the VLOS evaporates. A small portion of the spill remains in the water column as small droplets. The remaining oil could be physically or chemically dispersed, sedimented, beached, weathered into tar balls, or biodegraded.
- Information about where a very large spill could go and how long it takes to contact resources is estimated by an oil spill trajectory model.

Table 3. Results of AVALON/MERLIN discharge model for Chukchi Sea hypothetical VLOS well over maximum (74-day) time period estimated for mobilization, drilling, and completion of a relief well.

Time (days)	Oil Discharge Rate (bbls/d)	Gas Discharge Rate (Mcf/d)	Producing Rsi (GOR) Gas-Oil Ratio (scf/stb)	Water Discharge Rate (bbls/d)	Cumulative Oil Discharge (Mbbls)	Cumulative Gas Discharge (MMcf)	Cumulative Water Discharge (bbls)	Near-Wellbore Reservoir Pressure (psi)
0	0	0	930	0	0	0	0	4,392
0.1	50,671	47,124	930	0.06	5.1	4.7	0.0	4,168
1	61,672	50,677	822	0.16	61.8	52.2	0.1	3,937
2	57,485	46,357	806	0.18	120.5	99.8	0.3	3,875
3	53,987	43,035	797	0.20	175.1	143.5	0.5	3,827
4	52,246	41,030	785	0.23	226.1	183.9	0.7	3,777
5	48,669	38,101	783	0.23	274.8	222.0	1.0	3,747
6	46,581	36,312	780	0.25	321.4	258.4	1.2	3,707
7	45,036	34,931	776	0.26	366.4	293.3	1.5	3,666
8	43,596	33,607	771	0.27	410.0	326.9	1.7	3,627
9	42,239	32,343	766	0.28	452.2	359.2	2.0	3,591
10	40,889	31,100	761	0.29	493.1	390.3	2.3	3,558
11	39,529	29,923	757	0.29	532.6	420.3	2.6	3,528
12	38,306	28,974	756	0.30	570.9	449.2	2.9	3,499
13	37,219	28,148	756	0.30	608.2	477.4	3.2	3,473
14	36,364	27,583	759	0.31	644.5	505.0	3.5	3,445
15	35,580	27,035	760	0.32	680.1	532.0	3.8	3,420
16	34,930	26,628	762	0.33	715.0	558.6	4.2	3,394
17	34,316	26,178	763	0.33	749.4	584.8	4.5	3,370
18	33,750	25,767	763	0.34	783.1	610.6	4.8	3,347
19	33,199	25,330	763	0.34	816.3	635.9	5.2	3,325
20	32,662	24,885	762	0.35	849.0	660.8	5.5	3,304
21	32,130	24,436	761	0.35	881.1	685.2	5.9	3,284
22	31,608	23,995	759	0.35	912.7	709.2	6.2	3,265
23	31,094	23,577	758	0.35	943.8	732.8	6.6	3,247
24	30,596	23,178	758	0.36	974.4	756.0	6.9	3,230
25	30,115	22,800	757	0.36	1,004.5	778.8	7.3	3,213
26	29,648	22,443	757	0.36	1,034.2	801.2	7.7	3,197
27	29,200	22,110	757	0.36	1,063.4	823.3	8.0	3,181
28	28,750	21,788	758	0.36	1,092.1	845.1	8.4	3,165
29	28,319	21,499	759	0.36	1,120.4	866.6	8.7	3,150
30	27,917	21,245	761	0.37	1,148.3	887.9	9.1	3,136
31	27,539	21,029	764	0.37	1,175.9	908.9	9.5	3,121
32	27,166	20,806	766	0.37	1,203.0	929.7	9.9	3,106
33	26,805	20,599	768	0.37	1,229.9	950.3	10.2	3,092
34	26,452	20,415	772	0.37	1,256.3	970.7	10.6	3,079
35	26,124	20,256	775	0.38	1,282.4	991.0	11.0	3,065
36	25,817	20,115	779	0.38	1,308.2	1,011.1	11.4	3,052
37	25,534	20,006	784	0.38	1,333.8	1,031.1	11.7	3,038
38	25,250	19,886	788	0.38	1,359.0	1,051.0	12.1	3,025
39	24,974	19,787	792	0.39	1,384.0	1,070.8	12.5	3,012
40	24,719	19,707	797	0.39	1,408.7	1,090.5	12.9	2,999
41	24,474	19,637	802	0.39	1,433.2	1,110.1	13.3	2,986
42	24,251	19,595	808	0.39	1,457.4	1,129.7	13.7	2,973
43	24,034	19,552	814	0.40	1,481.5	1,149.2	14.1	2,961
44	23,821	19,522	820	0.40	1,505.3	1,168.8	14.5	2,948
45	23,620	19,513	826	0.40	1,528.9	1,188.3	14.9	2,936
46	23,434	19,518	833	0.41	1,552.4	1,207.8	15.3	2,923
47	23,259	19,531	840	0.41	1,575.6	1,227.3	15.7	2,911
48	23,110	19,579	847	0.42	1,598.7	1,246.9	16.1	2,898
49	22,946	19,617	855	0.42	1,621.7	1,266.5	16.5	2,885
50	22,797	19,682	863	0.42	1,644.5	1,286.2	17.0	2,873
51	22,665	19,765	872	0.43	1,667.1	1,306.0	17.4	2,860
52	22,543	19,856	881	0.43	1,689.7	1,325.8	17.8	2,847
53	22,434	19,972	890	0.44	1,712.1	1,345.8	18.3	2,835
54	22,325	20,098	900	0.44	1,734.4	1,365.9	18.7	2,822
55	22,228	20,252	911	0.45	1,756.7	1,386.2	19.2	2,809
56	22,150	20,425	922	0.46	1,778.8	1,406.6	19.6	2,795
57	22,042	20,566	933	0.46	1,800.9	1,427.1	20.1	2,783
58	21,918	20,699	944	0.47	1,822.8	1,447.8	20.6	2,770
59	21,807	20,869	957	0.47	1,844.6	1,468.7	21.0	2,758
60	21,688	21,030	970	0.48	1,866.3	1,489.7	21.5	2,745
61	21,580	21,203	983	0.48	1,887.8	1,510.9	22.0	2,733
62	21,475	21,381	996	0.49	1,909.3	1,532.3	22.5	2,720
63	21,369	21,566	1,009	0.49	1,930.7	1,553.9	23.0	2,708
64	21,284	21,804	1,024	0.50	1,952.0	1,575.7	23.5	2,695
65	21,193	22,032	1,040	0.51	1,973.2	1,597.7	24.0	2,683
66	21,112	22,276	1,055	0.51	1,994.3	1,620.0	24.5	2,670
67	21,033	22,532	1,071	0.52	2,015.3	1,642.5	25.0	2,657
68	20,955	22,799	1,088	0.53	2,036.3	1,665.3	25.5	2,644
69	20,868	23,078	1,106	0.53	2,057.1	1,688.4	26.1	2,632
70	20,777	23,350	1,124	0.54	2,077.9	1,711.8	26.6	2,619
71	20,693	23,637	1,142	0.55	2,098.6	1,735.4	27.2	2,606
72	20,615	23,934	1,161	0.55	2,119.2	1,759.3	27.7	2,594
73	20,539	24,248	1,181	0.56	2,139.8	1,783.6	28.3	2,581
74	20,479	24,608	1,202	0.57	2,160.2	1,808.2	28.8	2,567

Mcf/d, thousands of cubic feet per day; scf/stb, standard cubic feet or gas per stock-tank barrel of oil at 1 atmosphere (101.6 kilopascals) and 60°F (15.6°C) or surface conditions; Mbbls, thousands of barrels; MMcf, millions of cubic feet; psi, pounds per square inch (6.895 kiloipascals). "Near-Wellbore Reservoir Pressure" represents the formation pressure in the cell penetrated by the well.

Cause of Spill

This scenario begins with an unlikely event: a loss of well control during exploration drilling that leads to a long duration blowout and a VLOS.

For the purpose of the analysis, an explosion and subsequent fire are assumed to occur. A blowout associated with the drilling of a single exploratory well could result in a fire that would burn for 1 or 2 days. The exploration drilling rig or platform may sink. If the blowout occurs in shallow water, the sinking rig or platform may land in the immediate vicinity; if the blowout occurs in deeper water, the rig or platform could land a great distance away. For example, the *Deepwater Horizon* drilling rig sank, landing 1,500 feet from the subsea wellhead. Water depths in the majority of the Sale 193 area range from about 95 feet to approximately 262 feet; this range is considered shallow water. A small portion of the northeast corner of the Sale 193 area deepens to approximately 9,800 feet.

For the purpose of modeling flow rates, the location of the blowout and leak was specified as occurring near the mudline (at the top of the BOP). For the purpose of environmental effects analysis, it is acknowledged that a blowout could occur in other locations, such as at the sea surface, along the riser anywhere from the seafloor to the sea surface, or below the seafloor (outside the wellbore). The forthcoming environmental effects analysis in Section IV.E encompasses all these possibilities. As different blowout and leak locations may have bearing on spill response and intervention options, additional discussion of these issues is provided in Section IV.D.3, Opportunities for Intervention and Response.

Timing of the Initial Event

For purposes of analysis, the hypothetical VLOS is estimated to commence between July 15 and October 31. These dates coincide with the open water drilling season.

Any exploration drilling associated with Lease Sale 193 would be anticipated to occur within ten years of affirming or modifying the lease sale at the conclusion of this NEPA process. The lease sale can also be canceled, in which case no drilling would occur as a result of Lease Sale 193.

Volume of Spill

Well blowouts generally involve two types of hydrocarbons, namely crude oil (or condensate) and natural gas. The volume ratio of these two fluids is a function of the characteristics of the fluids and the producing reservoir.

Table 3 summarizes the results of the discharge model for the hypothetical VLOS. The oil discharge climbs rapidly to over 61,000 bbls/day during day one. After peaking in Day 1, Figure 15 shows that the oil discharge declines rapidly through the first 40 days of flow as the reservoir is depressurized by approximately 1,400 psi (Table 3). The decline in the flow rate flattens somewhat after Day 40. As shown in Table 3, the cumulative oil discharge over a 74-day spill is 2,160,200 bbls.

To simplify the analysis, we estimate 2.2 MMbbls (million barrels) of oil are spilled in the VLOS scenario.

Duration of Spill

The duration of the offshore spill from a blowout depends on the time required for successful intervention. Intervention may take a variety of forms. As discussed in Section IV.D.3., there exists a variety of methods by which an operator or responder can stop the flow of oil. The availability of some of these techniques could vary under individual drilling plans. Under NTL 2010-N06 (discussed in Section IV.D.1, above), all exploration plans must specify as accurately as possible the time it would take to contract for a rig, move it on site, and drill a relief well. For purposes of analysis within this VLOS scenario, we estimate the discharge would be stopped within 74 days of the initial event. This duration reflects the longest of three estimated time periods for completing a relief well as described in Table 4, below.

Table 4. Estimates for time periods required to drill a relief well and to kill the discharge at the Chukchi Sea VLOS well (provided by BOEMRE AKOCSR Field Operations).

1. Use of Original Drilling Platform and Equipment to Drill Relief Well	
Activity	**Time Estimate (days)**
Cleanup and resupply of original vessel	5
Construction of relief well cellar*	7
Drilling of relief well	18
Killing of VLOS (original) well	5
Weather downtime*	4
Total Time Required	**39**
2. Use of Second Drilling Platform and Equipment Prepositioned In-theatre (within Chukchi Sea) for Relief Well	
Activity	**Time Estimate (days)**
Plug and temporarily abandon well being drilled by second drilling platform	5
Cleanup and resupply of relief well vessel	5
Transport of relief well rig to VLOS well site	2
Construction of relief well cellar*	7
Drilling of relief well	18
Killing of VLOS (original) well	5
Weather downtime*	4
Total Time Required	**46**
3. Use of Second Drilling Platform and Equipment from Northern Hemisphere Pacific Rim for Relief Well	
Activity	**Time Estimate (days)**
Plug and temporarily abandon well being drilled by second (relief well) drilling platform	5
Cleanup of relief well vessel (performed en route—no additional time	0
Transport of relief well rig to VLOS well site	30
Resupply of relief well vessel	5
Construction of relief well cellar*	7
Drilling of relief well	18
Killing of VLOS (original) well	5
Weather downtime*	4
Total Required Time	**74**

*estimates based upon previous operations in the area

Area of Spill

When oil reaches the sea surface, it spreads. The speed and extent of spreading depends on the type of oil and volume that is spilled. A spill of the size analyzed here would likely spread hundreds of square miles. Also, the oil slick may break into several smaller slicks, depending on local wind patterns that drive the surface currents in the spill area. Estimates of where the oil spill would go were taken from the OSRA trajectory analysis (see Appendix B).

Oil in the Environment: Properties and Persistence

The fate of oil in the environment depends on many factors, such as the source and composition of the oil, as well as its persistence (National Research Council, 2003c). Persistence can be defined and measured in different ways (Davis et al., 2004), but the National Research Council (NRC) generally defines persistence as how long oil remains in the environment (National Research Council, 2003c). Once oil enters the environment, it begins to change through physical, chemical, and biological weathering processes (National Research Council, 2003c). These processes may interact and affect the properties and persistence of the oil through:

- evaporation (volatilization)
- emulsification (the formation of a mousse)
- dissolution
- oxidation
- transport processes (National Research Council, 2003c; Scholz et al., 1999)

Horizontal transport takes place via spreading, advection, dispersion, and entrainment while vertical transport takes place via dispersion, entrainment, Langmuir circulation, sinking, overwashing, partitioning, and sedimentation (Sale 193 FEIS, Appendix A.1, Figure A.1 and A.2). The persistence of an oil slick is influenced by the effectiveness of oil-spill response efforts and affects the resources needed for oil recovery (Davis et al., 2004). The persistence of an oil slick may also affect the severity of environmental impacts as a result of the spilled oil.

Crude oils are not a single chemical, but instead are complex mixtures with varied compositions. Thus, the behavior of the oil and the risk the oil poses to natural resources depends on the composition of the specific oil encountered (Michel, 1992). Generally, oils can be divided into three groups of compounds: (1) light-weight, (2) medium-weight, and (3) heavy-weight components.

The oil discharged from the hypothetical Chukchi Sea VLOS well is 35° API crude oil. This oil would be considered light-weight as shown in Table 5, below. On average, light-weight crude oils are characterized as outlined below in Table 5.

Previous studies (Boehm and Fiest 1982) supported the estimate that most released oil in shallow waters similar to the Chukchi Sea would reach the surface of the water column. A small portion (1-3%) of the Ixtoc oil remained in the water column (dispersants were used), although limited scientific investigation occurred and analytical chemical methods 30 years ago may not have been as sensitive as today (Boehm and Fiest, 1982; Reible, 2010).

Table 5. Properties and persistence for light-weight crude oil.

Light-weight Crude Oil – Properties and Persistence	
Hydrocarbon compounds	Up to 10 carbon atoms
API º	>31.1º
Evaporation rate	Rapid (within 1-3 days) and complete in summer; Slower (1-30 days) winter longer for complete evaporation
Solubility in water	High
Acute toxicity	High due to monoaromatic hydrocarbons (BTEX)
Chronic toxicity	Minor, does not persist due to evaporation
Bioaccumulation potential	Minor, does not persist due to evaporation
Compositional majority	Alkanes and cycloalkanes
Persistence	Low due to evaporation

Sources: Michel, 1992; Reed et al., 2005 [Sintef OWM]; Brandvik, Resby, and Daling et al., 2010

Release of Natural Gas

The quality and quantity of components in natural gas vary widely by the field, reservoir, or location from which the natural gas is produced. The oil in the VLOS reservoir is assumed to be initially saturated (with gas) at a gas-oil ratio of 930 cf/bbl (quantities at standard conditions of 60°F and 1.0 atm.) and this is reflected by the fact that the initial (Day 0.1) produced gas-oil ratio in the model (Table 3) is also 930 cf/bbl. As shown in Table 3, the produced gas-oil ratio falls to a minimum of 757 cf/bbl between Day 15 and Day 27—while early oil and gas production rates fall rapidly with de-pressurization of the reservoir near the wellbore—but then rises to 1,202 cf/bbl by Day 74 of the discharge.

Gas discharge reaches a peak of 50,677 Mcf/d in Day 1 of the flow, falls to a minimum rate of 19,513 Mcf/d by Day 45, then rises to 24,608 Mcf/d by Day 74. The pattern of gas flow reflects the process of gas break-out in the reservoir that progressively converts the initial oil reservoir into a gas reservoir. The cumulative gas discharge over the 74-day period (assumes the use of new platform and drilling equipment) estimated for completion of a relief well (very large discharge case) is 1,808 MMcf. For purposes of analysis we estimate 1.8 Bcf (billion cubic feet). Natural gas is primarily made up of methane (CH4) and ethane (C2H6) which make up 85-90% of the volume of the mixture.

Duration of Subsea and Shoreline Oiling

The duration of the shoreline oiling is measured from initial shoreline contact until the well is capped or killed and the remaining surface oil dissipates offshore. Depending on the spill's location in relation to winds, ice, and currents and the well's distance to shore, oil could reach the coast within 10 days to 360 days based on BOEMRE oil spill trajectory analysis (USDOI, MMS 2007). While it is estimated that the majority of spilled surface oil would evaporate and naturally disperse offshore within 30 days of stopping the flow or after meltout in the Arctic spring, some oil may remain in coastal areas until cleaned, as seen following the EVOS and DWH event (The State of Louisiana, 2010a-d). The generation of oil suspended particulate material or subsurface plumes from the well head would stop when the well was capped or killed. Subsurface plumes would disspate over time due to mixing and advection (Boehm and Fiest, 1982).

Volume of Oil Reaching Shore

In the event of a VLOS, not all of the oil spilled would contact shore. The volume of oil recovered and chemically or naturally dispersed would vary. For example, the following are recovery and cleanup rates from previous high-volume, extended spills (Wolfe et al., 1994; Gundlach and Boehm, 1981; Gundlach et al., 1983; Lubchenco et al., 2010):

- 10-40 percent of oil recovered or reduced (including burned, chemically dispersed, and skimmed).
- 25-40 percent of oil naturally dispersed, evaporated, or dissolved.
- 20-65 percent of the oil remains offshore until biodegraded or until reaching shore.

In the case of the DWH event, "it is estimated that burning, skimming and direct recovery from the wellhead removed one quarter (25%) of the oil released from the wellhead. One quarter (25%) of the total oil naturally evaporated or dissolved, and just less than one quarter (24%) was dispersed (either naturally or as a result of operations) as microscopic droplets into Gulf waters. The residual amount—just over one quarter (26%)—is either on or just below the surface as light sheen and weathered tar balls, has washed ashore or been collected from the shore, or is buried in sand and sediments" (Inter-agency, 2010a). For planning purposes, USCG estimates that 5–30 percent of oil will reach shore in the event of an offshore spill (33 CFR Part 154, Appendix C, Table 2.).

Length of Shoreline Contacted

While larger spill volumes increase the chance of oil reaching the shoreline, other factors that influence the length and location of shoreline contacted include the duration of the spill and the well's location in relation to winds, ice, currents, and the shoreline. As estimated from the OSRA model (explained in more detail in Section IV.E.1 and Appendix B), the length of oiled shoreline increases over time as the spill continues (Table 6). Dependent upon winds and currents throughout the very large oil spill event, already impacted areas could have oil refloated and oil other areas, increasing the estimates above.

Table 6. Length of discontinuous shoreline and contacted in summer and winter within a 360 day period (estimated from OSRA model) from Launch Areas 1–13.

Days from Spill Release	Summer			Winter		
	Number of LS contacted	Length of Discontinuous Shoreline Contacted from LA1–13		Number of LS contacted	Length of Discontinuous Shoreline Contacted from LA1–13	
		mi	km		mi	km
3 days	*	*		*	*	
10 days	0–3	0–150	0–240	0–3	0–150	0–240
30 days	0–12	0–600	0–960	0–5	0–250	0–400
60 days	0–13	0–650	0–1040	0–8	0–400	0–640
180 days	0–14	0–700	0–1120	0–16	0–800	0–1280
360 days	0–17	0–850	0–1360	0–16	0–800	0–1280

Note: * = less than 0.5 percent of trajectories contacting; therefore, no length calculated

A VLOS from a nearshore site would allow less time for oil to be weathered, dispersed, and/or recovered before reaching shore. This could result in a more concentrated and toxic oiling of the shoreline. A release site farther from shore could allow more time for oil to be weathered, dispersed, and recovered. This could result in a broader, patchier oiling of the shoreline.

Severe and Extreme Weather

Wind and wave action can drive oil floating on the surface into the water column, and oil stranded on shorelines can be moved into nearshore waters and sediment during storms. Episodes of severe and extreme weather over the Arctic could affect the behavior of sea-surface oil, accelerate biodegradation of the oil, impact shoreline conditions, and put marine vessels at risk. For instance, recovery of sea-surface oil could be impeded by the formation of sea ice during severe cold outbreaks that occur typically over the Arctic winter. In addition, episodes of severe storms characterized by strong winds (25 to 30 miles per hour) and precipitation can dictate the movement of sea-surface oil drift and also direct oil toward the coastline following a VLOS occurring during summer or winter. The severe storms, referred to as mesoscale cyclones (MCs), form when a cold air mass over land (or an ice sheet) moves over warmer open water (Nihoul and Kostianoy, 2009). These storms are usually small-scale and short-lived, and the lower the atmospheric pressure in the storm center, the stronger the storm. More intense versions of MCs occur mainly during the Arctic winter when the lowest pressure polar mesoscale cyclones (PMCs) are associated with the semi permanent Aleutian low. These storms can cause extreme weather conditions in areas near ice/ocean or land/ocean boundaries (Jackson & Apel, 2004). While less common, these storms cover a larger area and can cause surface winds at or near gale force, up to 45 miles per hour, with waves 15 to 20 feet. As such, a PMC is sometimes characterized as an Arctic hurricane. Wind and wave action caused by these extreme storms can pose a risk to marine vessels, drive sea-surface oil into the water column, enhance weathering of the oil, or cause oil stranded on the coastline to move into nearshore waters and sediment. Any of these conditions could temporarily delay or stop the response and recovery effort.

Recovery and Cleanup

The hypothetical VLOS scenario outlined thus far would trigger an extensive spill recovery and cleanup effort. It is anticipated that efforts to respond to a VLOS in the Chukchi Sea would include the recovery and cleanup techniques and estimated levels of activities described below. A more detailed description of the available methods to respond to an oil spill is provided in the Arctic Multi-Sale Draft EIS, in Section 4.3.3.5.5 (USDOI, MMS, 2008a). It is noted that severe weather and/or the presence of ice could interfere with or temporarily preclude each of these methods. The effect of ice is discussed in greater detail below in "Effect of Ice on Response Actions." For a comprehensive summary report of the 31 Arctic oil spill response research projects that BOEMRE has funded, the reader is referred to a report called "Arctic Oil Spill Response Research and Development Program:

A Decade of Achievement." This document is available at http://www.boemre.gov/tarprojectcategories/ArcticOilSpillResponseResearch.htm.

In the event of a VLOS, two governmental organizations would assume prominent roles in coordinating response efforts: the Federal On-Scene Coordinator (FOSC) the Alaska Regional Response Team (ARRT). The ARRT is an advisory board to the FOSC that provides federal, state, and local governmental agencies with means to participate in response to pollution incidents. During a response the FOSC would consult with the ARRT on a routine basis for input regarding response operations and priorities. In addition to their advisory role during a response event, the ARRT is responsible for developing the Alaska Federal/State Preparedness Plan for Response to Oil and Hazardous Substance Discharges/Releases (Unified Plan) which details governmental incident response planning and responsibilities for the State of Alaska and 10 Subarea Contingency Plans which provide region-specific response planning information for establishing operations in the event of a major response effort to an oil spill or hazardous material release. The Subarea Contingency Plans identify notification requirements, emergency response command structures, response procedures, community profiles, in-region response assets, logistics guidance, spill scenarios that could be encountered in the region and sensitive areas identification along with geographic response strategies which provide suggested response actions to protect the resources at risk from a release of oil. For exploration activities in the Chukchi Sea the North Slope Subarea Contingency Plan and the Northwest Arctic Subarea Contingency Plan are the applicable documents for addressing oil spill response in the region.

Mechanical Recovery. Both mechanical and non-mechanical methods of oil spill response can be utilized in the Chukchi Sea to mitigate the impacts of an oil spill on the environment. The preferred means of spill response is mechanical recovery of the oil, which physically removes oil from the ocean. Mechanical recovery is accomplished through the use of devices such as containment booms and skimmers. A containment boom is deployed in the water and positioned within an oil slick to contain and concentrate oil into a pool thick enough to permit collection by a skimmer. The skimmer collects the oil and transfers it to a storage vessel (storage barges or oil tankers) where it will eventually be transferred to shore for appropriate recycling or disposal.

Dispersants. Use of chemical dispersants is a response option for the Chukchi Sea. Research has shown that dispersants can be effective in cold and ice infested waters when employed in a timely manner (S.L. Ross Environmental Research Ltd., 2002, 2003, 2006, 2007; Belore, 2003). Recently completed field scale tests conducted by Sintef (Sintef, 2010) as part of the Oil in Ice Joint Industry Project (JIP) in the Barents Sea have demonstrated that results from lab scale and large wave tank tests hold true in actual ocean conditions. Oil released into the ocean during broken ice conditions was readily dispersed and addition of vessel propeller wash for increased wave energy results in increased oil dispersion in these conditions. It was also demonstrated that in these cold conditions weathering of the oil was significantly slowed providing a greater window of opportunity in which to successfully apply dispersants. Dispersant application can be accomplished by means of injection at the source or through aerial or vessel based application. There are dispersant stockpiles located in Prudhoe Bay, Anchorage and the Lower 48 states. Dispersant use is limited to ocean application in waters generally deeper than 10 meters; this depth restriction is used to avoid or reduce potential toxicity concerns with respect to nearshore organisms.

The State of Alaska does not have preapproved dispersant application zones for the Chukchi Sea, so each request for dispersant application would be evaluated and approved or disapproved on a case-by-case basis by the FOSC in consultation with the ARRT. The decision regarding how and when dispersants would be applied would also reside with the FOSC and the ARRT. Procedures governing the application of dispersants are provided in "The Alaska Federal and State Preparedness Plan for Response to Oil and Hazardous Substance Discharges and Releases" (Unified Plan) (ARRT, 2010).

However, the FOSC is not limited to this procedure and may utilize other sources of information in determining what the most appropriate dispersant method would be given a specific situation.

In-situ Burning. In-situ burning is also a viable response method for the Chukchi Sea and could be approved by the FOSC in consultation with the Unified Command and the ARRT. Any in-situ burning would be conducted in accordance with the Alaska Unified Plan In-situ Burn Guidelines (ARRT, 2010). In-situ burning is a method that can be used in open ocean, broken ice, near shore and shoreline cleanup operations. In broken ice conditions the ice serves to act as a natural containment boom limiting the spread of oil and concentrating it into thicker slicks, which aid in starting and maintaining combustion. In-situ burning has the potential to remove in excess of 90% of the volume of oil involved in the burn. In-situ burning experiments of oil in ice conducted as part of the Sintef JIP (Sintef, 2010) has likewise demonstrated that cold temperatures serve to slow weathering of the oil, in turn expanding the window of opportunity for in-situ burning application over that experienced in more temperate regions.

Effect of Ice on Response Actions. For all response options the presence of ice can both aid and hinder oil spill response activities. Ice acts as a natural containment device preventing the rapid spread of oil across the ocean surface; it also serves to concentrate and thicken the oil allowing for more efficient skimming, dispersant application and in-situ burning operations. Once shore fast ice is formed, it serves as a protective barrier limiting or preventing oil from contacting shorelines. Cold temperatures and ice will slow the weathering process by reducing volatilization of lighter volatile compounds of the oil, reducing impact of wind and waves, and extending the window of opportunity in which responders may utilize their response tools.

Conversely ice can limit responder’s ability to detect and locate the oil, access the oil by vessel, prevent the flow of oil to skimmers, require thicker pools to permit in-situ burning and eventually encapsulate the oil within a growing ice sheet making access difficult or impossible. Once incorporated into the ice sheet, further recovery operations would have to cease until the ice sheet becomes stable and safe enough to support equipment and personnel to excavate and/or trench through the ice to access the oil. The other response option is embedding tracking devices in the ice and monitoring its location until the ice sheet begins to melt and the oil surfaces through brine channels, at which time it could be collected or burned.

Levels of Recovery and Cleanup Activities. The levels of activities required to apply the techniques described above are dependent on the specific timing and location of a spill. As weather, ice, and logistical considerations allow, the number of vessels and responders would increase exponentially as a spill continues. The levels of activities described below are reasonable estimates provided as a basis for analysis. These estimates are based on Subarea Contingency Plans for the North Slope and northwest Arctic subareas, past spill response and cleanup efforts including the EVOS and DWH events, and the best professional judgment of BOEMRE spill response experts.

- Between 5 and 10 staging areas would be established.
- About 15 to 20 large skimming vessels (i.e. the Nanuq, Endeavor Barge, Tor Viking, other barges from Prudhoe Bay, USCG skimming vessels, vessels from Cook Inlet and Prince William Sound) could be used in offshore areas. The majority of open ocean vessels would be positioned relatively close to the source of the oil spill to capture oil in the thickest slicks, thus enabling the greatest rate of recovery.
- Thousands of responders (from industry, the Federal government, and private entities) could assist spill response and cleanup efforts as the spill progresses. Weather permitting, roughly 300-400 skimming, booming, and lightering vessels could be used in areas closer to shore. Based on the trajectory of the slick, shallow water vessels would be deployed to areas identified as priority protection sites.

- Booming would occur, dependent upon the location of the potentially impacted shoreline, environmental considerations, and agreed upon protection strategies involving the local potentially impacted communities. About 100 booming teams could monitor and operate in multiple areas.
- Use of dispersants and/or in-situ burning could occur if authorized by the Federal On-Scene Coordinator (FOSC). Use of dispersants would likely concentrate on the source of the flow or be conducted so as to protect sensitive resources. In-situ burning operations would likewise be conducted in the area of thickest concentration to ensure the highest efficiency for the effort. In-situ burning may also be utilized in nearshore and shoreline response where approved by FOSC.
- Dozens of planes and helicopters would fly over the spill area, including impacted coastal areas. Existing airport facilities along the Arctic coast (including airports at Kotzebue, Point Hope, Point Lay, Wainwright, Barrow, and any other suitable airstrips) would be used to support these aircraft. If aircraft are to apply dispersants, they could do so from altitudes of 50 to 100 feet.
- Workers could be housed offshore on vessels or in temporary camps at the 5–10 staging areas.

Depending on the timing and location of the spill, the above efforts could be affected by seasonal considerations. In the event that response efforts continue into the winter season, small vessel traffic would come to a halt once the forming ice begins to cover the ocean surface. Larger skimming vessels could continue until conditions prevent oil from flowing into the skimmers. At this point, operations could shift to in-situ burning if sufficient thicknesses are encountered. The lack of daylight during winter months would increase the difficulties of response.

As ice formation progresses, the focus of the response would shift to placing tracking devices in the forming ice sheet to follow the oil as it is encapsulated into the ice sheet. Once the ice sheet becomes solid and stable enough, recovery operations could resume by trenching through the ice to recover the oil using heavy equipment. This would most likely occur in areas closer to shore because the ice would be more stable. In late spring and early summer, as the ice sheet rots, larger ice-class vessels could move into the area and begin recovery or in-situ burning operations as the oil is released from the ice sheet. The ice would work as a natural containment boom keeping the oil from spreading rapidly. As the ice sheet decays, oil encapsulated in the ice would begin surfacing in melt pools at which time responders would have additional opportunities to conduct in-situ burn operations. Smaller vessels could eventually re-commence skimming operations in open leads and among ice flows, most likely in a free skimming mode (without boom) along the ice edge.

While it is estimated that the majority of spilled oil on the water surface would be dissipated within a few weeks of stopping the flow (Inter-agency, 2010a) during open water or after meltout in the Arctic spring, oil has the potential to persist in the environment long after a spill event and has been detected in sediment 30 years after a spill (Etkin, McCay, and Michel, 2007). On coarse sand and gravel beaches, oil can sink deep into the sediments. In tidal flats and salt marshes, oil may seep into the muddy bottoms (USDOI, FWS, 2010g).

Effectiveness of intervention, response and cleanup efforts depends on the spatial location of the blowout, leak path of the oil and amount of ice in the area. For the purpose of analysis, effectiveness of response techniques is not factored into the spill volume posited by this scenario and considered during OSRA modeling.

Scenario Phases and Impact-Producing Factors

This section specifically identifies the manners in which the hypothetical VLOS event described above could adversely impact the environment. The intent of this section is to facilitate thorough yet focused impacts analysis in Section IV.E.

The events constituting the VLOS scenario are first categorized into five distinct phases. These phases, which range from the initial blowout event to long-term recovery, are presented chronologically. Within each phase are one or more components that may cause adverse impacts to the environment. These components are termed "Impact Producing Factors," or IPFs, and will be used in Section IV.E. to guide the environmental impacts analysis. The specific IPFs listed here are intended to inform, rather than limit, the discussion of potential impacts in Section IV.E.

Well Control Incident (Phase 1)

Phase 1 of the hypothetical VLOS scenario comprises the catastrophic blowout and its immediate consequences. Potential IPFs associated with Phase 1 include the following:

- Explosion. Natural gas released during a blowout could ignite, causing an explosion.
- Fire. A blowout could result in a fire that could burn for 1 to 2 days.
- Re-distribution of Sediments. A subsea blowout could re-distribute sediment along the seafloor.
- Sinking of Rig. The drill rig could sink to the sea floor.
- Psychological/Social Distress. News and images of a traumatic event could cause various forms of distress.

Offshore Spill (Phase 2)

Phase 2 of the scenario encompasses the continuing release of an oil spill in Federal and State offshore waters. Potential IPFs associated with Phase 2 include the following:

- Contact with Oil. Offshore resources (including resources at surface, water column, and sea floor) could be contacted with spilled oil.
- Contamination. Pollution stemming from an oil spill may contaminate environmental resources, habitat, and/or food sources.
- Loss of Access. The presence of oil could prevent or disrupt access to and use of affected areas.

Onshore Contact (Phase 3)

Phase 3 of the scenario focuses on the continuing release of an oil spill and contact with coastline and State nearshore waters. Potential IPFs associated with Phase 3 include the following:

- Contact with Oil. Onshore resources could come into direct contact with spilled oil.
- Contamination. Pollution stemming from an oil spill may contaaminate environmental resources, habitat, and/or food sources.
- Loss of Access. The presence of oil could prevent or disrupt access to and use of affected areas.

Spill Response and Cleanup (Phase 4)

Phase 4 of the scenario encompasses spill response and cleanup efforts in offshore Federal and State waters as well as onshore Federal, State and private lands along the coastline. Potential IPFs associated with Phase 4 include the following:

- Vessels. Vessels could be used in support of spill response and cleanup activities.
- Aircraft. Aircraft could be used in support of spill response and cleanup efforts.
- In-situ burning. Remedial efforts may include burning of spilled oil.
- Animal Rescue. Animals may be hazed or captured and sent to rehabilitation centers.
- Dispersants. Dispersants could be introduced into the environment.
- Skimmers. Boats equipped to skim oil from the surface.
- Booming. Responders could deploy booms—long rolls of oil absorbent materials that float on the surface and corral oil.
- Beach cleaning. Cleanup efforts including hot water washing, hand cleaning using oil absorbent materials, and placement and recovery of sorbent pads, could be used on beaches and other coastal areas contacted by an oil spill.
- Drilling of Relief Well. A relief well could be drilled by the original drilling vessel or by a second vessel with additional support.
- Co-opting of resources. Funds, manpower, equipment, and other resources required for spill response and cleanup would be unavailable for other purposes.
- Bioremediation. Contaminated material could be removed or treated by adding fertilizers or microorganisms that "eat" oil.

Post-Spill, Long-Term Recovery (Phase 5)

Phase 5 of the scenario focuses on the long-term. The exact length of time considered during this Phase would vary by resource. Potential IPFs associated with Phase 5 include the following:

- Unavailability of environmental resources. Environmental resources and food sources may become unavailable or more difficult to access or use.
- Contamination. Pollution stemming from an oil spill may contaminate environmental resources, habitat, and/or food sources.
- Perception of contamination. The perception that resources are contaminated may alter human use and subsistence patterns.
- Co-opting of human resources. Funds, manpower, equipment, and other resources required to study long-term impacts and facilitate recovery would curtail availability for other purposes.
- Psychological/Social Distress. Distress stemming from a VLOS could continue into the long-term.

IV.D.3. Opportunities for Intervention and Response

In providing a duration for the hypothetical oil spill described above, it is stated for the purposes of analysis that the discharge would cease within 74 days of the initial event. The use of 74 days corresponds to the longest of three time periods estimated for a second drilling vessel to arrive on scene and complete a relief well (see Table 4). This is a reasonable, but conservative estimate, because it does not take into consideration the variety of other methods that would likely be employed to halt the spill within this period. Moreover, specific exploration plans may include intervention and response methods that could control or contain the flow of oil sooner than 74 days. This point is illustrated by recent exploration plans submitted for the Alaska OCS, such as the Shell Gulf of Mexico, Inc. 2009 approval of an exploration plan for leases in the Chukchi Sea. Between the Chukchi Sea Regional Exploration Oil Discharge Prevention and Contingency Plan (cPlan) (available at http://alaska.boemre.gov/fo/ODPCPs/2010_Chukch_cPlan.pdf) submitted with the EP application and additional safety measures submitted by Shell Gulf Mexico, Inc. after the Deepwater Horizon event, this proposal contained measures including:

- Enhanced BOP mechanisms
- Criteria and procedures for moving the drilling unit off location in event of abnormal conditions
- Pre-positioning of response vessels at the drill site and close to the shoreline
- Use of an Oil Spill Response Vessel capable of deploying and operating recovery equipment within an hour of notification
- Availability of a second BOP stack
- Maintaining supplies and equipment for relief well purposes

Potential intervention and response methods are qualitatively discussed below because their inclusion in individual exploration plans could serve to substantially decrease the duration, volume, and environmental effects of a VLOS. These methods are not mutually exclusive; several techniques may be employed if necessary. It may also be possible to pursue multiple techniques contemporaneously. Again, these opportunities for intervention and response could be employed prior to drilling a relief well, and are not factored into the estimated spill duration as described in the VLOS scenario above. The availability and effectiveness of these techniques may vary depending on the nature of the blowout, as well as seasonal considerations. For instance, an operators' ability to complete a relief well during winter months could be compromised by severe weather and cold, ice, darkness, and other factors.

Well Intervention. If a blowout occurred, the original drilling vessel would initiate well control procedures. The procedures would vary given the specific blowout situation, but could include:

- activating blowout preventer equipment
- pumping kill weight fluids into the well to control pressures
- replacing any failed equipment to remedy mechanical failures that may have contributed to the loss of well control
- activating manual and automated valves to prevent flows from coming up the drill string

These techniques cure loss-of-well-control events the vast majority of the time without any oil being spilled.

Natural bridging or plugging could also occur. These terms refer to circumstances where a dramatic loss of pressure within the well bore (as could occur in the event of a blowout) causes the surrounding formation to cave in, thereby bridging over or plugging the well. While natural bridging or plugging could render certain forms of operator-initiated well control infeasible, it could also impede or block the release of hydrocarbons from the reservoir from reaching the surface.

Containment Domes. In the event that well intervention is unsuccessful and the flow of oil continues, a marine well containment system (MWCS) could be deployed with associated support vessels. The design for a MWCS specific to Arctic operations is currently in progress and will receive BOEMRE review under future permitting activities. The MWCS is anticipated to provide containment domes, well intervention connections, ROV (remotely operated vehicle) capabilities, barge with heavy lift operations, separation equipment, and oil and gas flaring capabilities.

Relief Wells. If the above techniques are unavailable or unsuccessful, a relief well could be drilled. The relief well is a second well, directionally drilled, that intersects the original well at, near, or below the source of the blowout. Once the relief well is established, the operator pumps kill weight fluids into the blowout well to stop the flow and kill the well. Both wells are then permanently plugged and abandoned.

Some exploratory drilling vessels are capable of drilling their own relief well. Mobile Offshore Drilling Units, or MODUs, can disconnect from the original well, move upwind and up current from the blowout location, and commence the drilling of a relief well. Bottom-founded vessels are by definition not capable of maneuvering in this manner.

Second Vessel. Should the original drilling vessel sustain damage or prove otherwise incapable of stopping the blowout, a second vessel could be brought in to terminate or otherwise contain the blowout. A second vessel, with support from additional vessels as needed, could employ similar techniques to those described above. The time required by a second vessel to successfully stop the flow of oil must factor in the time needed for travel to the site of the blowout. The location of a second vessel is thus critical when considering a scenario in which same vessel intervention or response is unavailable. The estimate used in the VLOS scenario described above conservatively allots 30 days for transporting a second vessel across the Pacific Ocean. The availability of a second vessel in-theater (within the Chukchi Sea or possibly the Beaufort Sea) or on site would substantially reduce transport time and, therefore, the time needed for successful intervention. This could equate to shorter spill duration and smaller overall spill volume.

As previously mentioned, the availability and/or effectiveness of certain response and intervention techniques can depend on the type and exact location of the blowout. Four major distinctions with respect to the specific location of a blowout are important to consider. A blowout and leak could occur (1) at the sea surface (but the rig is not destroyed or sunk on location), (2) along the riser anywhere from the seafloor to the sea surface, (3) at the seafloor through leak paths on the BOP/wellhead, (4) below the seafloor, outside the wellbore, or (5) at the sea surface (but the rig is destroyed and sinks at the location). Opportunities for operational intervention and response vary in each of these circumstances (Table 7) and are, ultimately, important in determining the potential effects of the spill.

Table 7. Blowout scenarios and key differences in impacts, response, and/or intervention.

Location of Blowout and Leak	Key Differences in Impacts, Response, and/or Intervention
1. At the sea surface but rig is not destroyed or sunk on location.	Drilling unit is damaged and unable to drill, but is available for well intervention efforts or can be removed from the site. Offers the best chance for oil recovery due to access to the release point if vessel can remain on station or other intervention vessels can access the site.This allows for other intervention measures such as capping and possible manual activation of Blow-Out-Preventer (BOP) rams using the existing drilling unit. Greatest possibility for recovery of oil at the source, until the well is capped or killed.
2. Along the riser anywhere from the seafloor to the sea surface.	Divers or ROVs could be used in intervention to trace and seal leak points, depending on water depths. There is a possibility for recovery of oil at the source. In addition to relief wells, there is potential for other intervention measures, such as capping and possible manual activation of BOP rams.
3. At the seafloor, through leak paths on the BOP/wellhead	With an intact subsea BOP, intervention may involve the use of drilling mud to kill the well. If the BOP is heavily damaged it may be removed and replaced with an operable BOP.
4. Below the seafloor, outside the wellbore (i.e., broached)	Disturbance of a large amount of sediments resulting in the burial of benthic resources in the immediate vicinity of the blowout. The use of subsea dispersants would likely be more difficult (PCCI, 1999). Stopping this kind of blowout would probably involve relief wells. Any recovery of oil at the seabed would be very difficult.
5. At the sea surface; rig is destroyed and sinks at the location.	Area surrounding well is unavailable due to sunken vessel or ice incursions. Offers the least chance for oil recovery due to the restricted access to the release point.

IV.E. Effects of a VLOS

This section presents detailed analysis of the environmental impacts that could occur in the event of the hypothetical VLOS scenario described in the preceding section—potential impacts on 17 categories of unique resources are analyzed. For each resource, the types of potential direct, indirect, and cumulative impacts are evaluated. This evaluation proceeds by identifying the critical IPFs (impact producing factors) in each phase of the scenario that could affect the resource, and then providing a discussion of those potential effects for each component (e.g. a species) of the resource. Following this treatment of the types of potential effects, an OSRA model of simulated oil spill trajectories is used to evaluate the potential for oil from specific hypothetical launch areas to reach a given resource. The model and its components are further explained below and discussed in detail in Appendix B. A conclusion is provided for each resource area. Each Conclusion section also discusses the difference in potential impacts to a resource under the three action alternatives. If the decision maker selects Alternative II, the No Action alternative, no VLOS or VLOS-related impacts would result from Sale 193.

The reader may notice that this VLOS effects analysis is organized slightly differently than the Sale 193 FEIS environmental effects analysis and the portion of this Final SEIS evaluating potential effects from natural gas development and production. Here, the organization of environmental resources is driven more by biological characteristics as opposed to regulatory distinctions. For instance, potential impacts to marine and coastal birds are considered in one section that includes both ESA-listed and non-listed species. All cetaceans are considered together; the practice of separating Threatened and Endangered Marine Mammals from Other Marine Mammals is not applied in this case. Walrus and ice seal are each provided their own sections.

This format was deemed preferable for the VLOS analysis for two reasons. First, ongoing evaluation of several species for changes in status under the ESA may have led to confusing document re-organizations as the Revised Draft SEIS progresses to Final SEIS. Second, different organization may remind one of the unique purpose of this section: to analyze an extremely low probability, high impact event. This VLOS scenario is conditioned on the occurrence of many events, including but not limited to:

- Secretarial approval of Lease Sale 193 in some form
- Industry submittal and BOEMRE approval of an Exploration Plan and an Application for Permit to Drill
- Drilling of an exploratory well
- Encountering a significant oil accumulation in a permeable reservoir (in an exploratory well)
- A loss of well control while drilling
- An uncontrolled blowout
- An inability to stop the flow of oil for up to 74 days

IV.E.1. OSRA Model (Oil Spill Trajectories)

BOEMRE uses an OSRA (Oil Spill Risk Analysis) model to simulate estimated oil spill trajectories; in other words, the OSRA model is a method for estimating where a VLOS may go. It is an exercise in probability. For this analysis, BOEMRE presumes an oil spill occurs and the model estimates the percentage of oil spill trajectories that could contact environmental resource areas (ERAs), land segments, boundary segments, or grouped land segments. Uncertainty exists regarding every parameter of a hypothetical VLOS because this is a highly unlikely event for which location and environmental conditions (e.g. wind, ice, and currents) must be estimated based upon the best available data. Although some of the uncertainty reflects imperfect data, a considerable amount of uncertainty exists simply because it is difficult to predict events 15-40 years into the future. For purposes of analysis, BOEMRE estimates the source of the accidental spill, its size, where potential trajectories may travel to, and how it might weather. A consistent set of estimates about a VLOS is used to analyze the impacts to social, economic, and environmental resources. The source, size and general weathering of a very large oil spill have been addressed in Section IV.D.2. and Appendix B.

There are some differences between this analysis and BOEMRE's earlier analysis of a large oil spill in the Sale 193 FEIS (Appendix A, Section C; incorporated by reference). The Sale 193 FEIS evaluated a large oil spill (≥1,000 bbls) using the conditional probabilities of contact assuming a large oil spill occurred. The Sale 193 FEIS analysis used 13 launch areas (LAs) within the sale area representing the places where a spill could originate from an exploration or development activity. The analysis also used 87 environmental resource areas (ERAs), 126 land segments (LSs), 39 boundary segments (BSs) and 15 grouped land segments (GLS) representing biological, economic or social resources (see the Sale 193 FEIS, Appendix A: Maps A.1-1-A.1-3 and Tables A.1-12-A.1-16). The larger scope of the VLOS scenario warranted consideration of more ERAs than were used in the Sale 193 FEIS OSRA. Analysts were asked to identify any additional ERAs useful for understanding potential impacts of a VLOS. Three additional ERAs (74, 83 and 91) for whales in Russian waters were incorporated from Table A.1-15 in the Arctic Multi-Sale Draft EIS (USDOI, MMS, 2008a) and EFH polygons (Appendix C) were developed and analyzed because conditional probability data was not available from the Sale 193 FEIS. Further information and figures are provided in Appendix B.

We use the Sale 193 conditional probabilities for a VLOS analysis to estimate the percentage of trajectories from a VLOS contacting biological, social and economic resources of concern in and adjacent to the Sale 193 area. No special OSRA run was conducted to estimate the percentage of trajectories contacting resources from a hypothetical future catastrophic blowout and high volume, long duration flow resulting in a very large oil spill. The Arctic OSRA calculations are run for as long as 360 days and were appropriate for a very large oil spill with long duration. For purposes of this VLOS analysis, the conditional probabilities were considered to represent the estimated percentage of trajectories contacting an environmental resource area, land segment, boundary segment or grouped land segment. Higher percentages of trajectories contacting a given location could mean more oil reached the location depending upon weathering and environmental factors.

The hypothetical scenario provided in Section IV.D.2 suggests that a very large oil spill could begin at any point during the drilling season, which is between July 15 and October 31. The time period for a relief well ranges from 39 to 74 days. For the shortest period we considered that spilled oil remains on the surface of the water for a few weeks, and a 60 day contact period for the summer open-water season is appropriate (S.L. Ross Environmental Research Ltd. et al., 2003; Ramseur, 2010). For the longer period we considered that spilled oil could freeze into the sea ice, remain through the winter, and be released in the spring, a period of up to 360 days. We analyze oil spill trajectories for 60 and 360 days during summer. A very large oil spill continuing after October 31 is also treated as a winter spill. Trajectories launched on or after November 1 are treated as winter spills. Oil released during this period could freeze into the sea ice, remain all winter, and be released in the spring, a period of up to 360 days. We analyze oil spill trajectories for 360 days during winter. The percentage of trajectories contacting for summer (60 and 360 days) and for winter (360 days) are shown in Appendix B (Tables B-7 to B-22). Appendix B (Tables B-23 to B-25) shows the estimated percentage of trajectories contacting for EFH illustrated in Appendix C (Figures C-1 and C-6 to C-8).

Within each resource for which these distinctions are meaningful, the subsection Oil Spill Trajectory Analysis considers the percentage of trajectories contacting the particular environmental, social or economic resource. The percentage of trajectories is the fraction of the total trajectories launched from a given location (launch area) that are estimated to contact a given resource (ERA, LS, etc.). These percentages provide a relative estimate of how likely it is that oil from a VLOS will reach that resource. In addition, these trajectories are estimated separately for winter and summer seasons. In this way, the trajectory analysis also helps BOEMRE evaluate how the timing (season) and location of a VLOS relates to potential impacts of a VLOS on each resource. Below, a general summary is provided with respect to differences in timing and location as estimated by the model.

Launch Areas (LAs) 1 through 13 are the areas where a VLOS could originate from a well control incident (Appendix B, Figure B-10). The primary differences in contact between hypothetical launch areas are geographic in the perspective of west to east and nearshore versus offshore. Oil originating from offshore spill locations takes longer to contact the coast and nearshore ERAs, if contact occurs at all. Winter spill contact to nearshore and coastal resources is less frequent and would affect a lesser extent of the coastline due to the landfast ice generally in place from December to April. Specific groups of LAs show the following trajectory patterns:

- Hypothetical trajectories from LAs 7, 8 and 13 show the stochastic influence of the Beaufort Gyre.
- Hypothetical trajectories from LAs 1, 4, 5 and 10 have a stochastic northerly direction influenced by flow through the central channel as well as a southwestward component.
- LA 9 has a stochastic southwestward direction influenced by counterclockwise flow in the southern Chukchi Sea.
- LAs 5, 11, and 12 are influenced both in a northerly direction from flow in the central channel as well as from the Beaufort Gyre.

A VLOS trajectory analysis was evaluated for all resources except economy, air quality, sociocultural, and archaeology. Specific environmental resource areas and their vulnerability are not identified for these resources. However, the general results of the trajectory analysis were considered in estimating impacts on these resources.

IV.E.2. Water Quality

This section assesses the potential for the hypothetical VLOS scenario to impact water quality in the Chukchi Sea and the State of Alaska waters contiguous with the OCS areas (Figure B-1). The Sale 193 FEIS and the Arctic Multi-Sale Draft EIS detail the results of a large oil spill analysis and its effects on water, and they are incorporated here by reference (USDOI, MMS, 2007, 2008a).

Water quality is a term used here to describe the chemical, physical, and biological characteristics of water and sediment, usually with respect to its suitability for a particular purpose.

A waterbody in its natural state is characterized by its biological diversity and species abundance. Water quality naturally varies throughout the year 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 hydrocarbon seeps, seasonal changes in turbidity and nutrients due to terrestrial runoff and localized upwelling of cold water.

Water quality can be affected by anthropogenic (human-generated) pollution, habitat disturbance or destruction and other negative stressors such as aquatic invasive species. The Chukchi Sea OCS water quality to date has had relatively little exposure from land-based and marine anthropogenic pollution. The rivers that flow into the area remain relatively unpolluted by human activities. Industrial and shipping impacts on water quality have been and are relatively low at this time. Existing degradation of water quality is primarily related to aerosol transport and deposition of pollutants, pollutant transport into the region by sea ice, biota and currents, and effects from increasing greenhouse gases in the atmosphere, which affect water temperature and acidity (AMAP, 1997, 2004; Hopcroft et al., 2008).

The U.S. Environmental Protection Agency (USEPA) administers and enforces the Clean Water Act in cooperation with other Federal agencies, native tribes, state governments, municipal governments and industries. Currently, the water quality of the Chukchi Sea OCS is within the criteria for the protection of marine life according to Clean Water Act, Section 403 and no waterbodies are identified as impaired (Clean Water Act, Section 303) within the Arctic region by the State of Alaska (ADEC, 2011).

When determining whether a marine discharge would cause unreasonable degradation of water quality, the USEPA considers 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 and sediment 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 at 40 CFR 131.36. The Alaska water quality regulations are within 18 AAC 70.

Hydrocarbon concentrations in water have been measured in various major oil spills around the world. Four months into the *Ixtoc* blowout (Gulf of Mexico, 1979–1980 at approximately 50 m water depth), liquid hydrocarbons in the spill plume measured >10 ppm within 8 km of the blowout, to 0.02 ppm at 24 km from the blowout, and to <0.005 ppm at 40-km from the blowout (Boehm et al., 1982). The dispersant, Corexit 9527, had been applied to surface waters via aerial application to disperse oil in the region of the *Ixtoc* spill. Similarly, relative decreases were found for specific toxic compounds such as benzene and toluene (National Research Council, 1985).

At the *Ekofisk Bravo* blowout in the North Sea (1977, surface) concentrations of volatile liquid hydrocarbons (present mostly as an oil-in-water emulsion) ranged up to 0.35 ppm within 19 km of the site when measured, starting 1.5 days into the 7.5 day blowout (Grahl-Nielsen, 1978). Lesser amounts of oil (<0.02 ppm) were detectable in some samples, at 56-km from the site, but not at 89-km. 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 (Mackay and Wells, 1983).

Camilli et al. (2010) conducted a subsurface hydrocarbon study two months after the *Deepwater Horizon* (DWH) seafloor blowout (depth 1,500 m) in the Gulf of Mexico. They found a continuous oil plume at a depth of approximately 1,100 m that extended for 35 km from the blowout site. The plume consisted of monoaromatic hydrocarbons (benzene, toluene, ethylbenzene and xylene) at concentrations greater than 50 micrograms per liter. The plume persisted for months at this depth with no substantial biodegradation. They also measured concentrations throughout the water column and found similarly high concentrations of aromatic hydrocarbons in the upper 100 m. Polycyclic aromatic hydrocarbons were found at very high concentrations (reaching 189 micrograms per liter) by Dierks et al. (2010) after the DWH at depths between 1,000 and 1,400 m extending as far as 13 km from the subsurface blowout site.

Joye et al. (2011) estimated that the DWH released 500,000 tons of hydrocarbon gasses at depth, which would comprise 40% of the total hydrocarbons released from the DWH. Methane, ethane, propane, butane and pentane were measured throughout the water column. They found high concentrations of dissolved hydrocarbon gasses in a water layer between 1,000 and 1,300 m. These concentrations exceeded the background concentration of hydrocarbon gasses by up to 75,000 times. Results from a study by Yvon-Lewis et al. (2011) showed that, beginning 53 days after the DWH and for 7 days of continuous chemical analysis at sea, there was a low flux of methane from the DWH blowout to the atmosphere. Based on these methane measurements at the surface water and concurrent measurements at depth, they concluded that the majority of methane from the blowout remained dissolved in the deep ocean waters. Valentine et al., (2010) reported that 2 months after the DWH blowout, propane and ethane gases at depth were the major gases driving rapid respiration by bacteria. They also found these gases at shallower depths but at concentrations that were lower by orders of magnitude. Multiple plumes transported in different directions were detected at depth, indicating complex current patterns.

Methane release in the DWH blowout and biodegradation by deepwater methanotrophs was studied by Kessler, et al (2011). They found that a deepwater bacterial bloom respired the majority of the methane in approximately 120 days. Similarly, Hazen et al. (2010) found indigenous bacteria at 17 deepwater stations biodegrading oil 2-3 months after the DWH blowout. The fate of 771,000 gallons of chemical dispersants injected at the DWH wellhead near the seafloor (1,500 m) was studied by Kujawinski et al. (2011). Their results show that the dispersants injected at the wellhead were concentrated in hydrocarbon plumes at 1,000-1,200 m depth 64 days after dispersant application was stopped and as far away as 300 km. They concluded that the chemical dispersants at this depth underwent slow rates of biodegradation.

The conditions in the waters of the Gulf of Mexico (and specifially at the *Deepwater Horizon* site) differ from the conditions present in the Chukchi Sea. The DWH blowout occurred in at a depth of 1,500 m; potential Chukchi Sea drilling would be at <50 m. This depth difference is important given how gas and liquids behave differently at various pressures, with more gas staying in solution at greater depths. A greater depth may also present a greater likelihood that distinct density layers and currents that could entrain and transport hydrocarbons. In the summer, the shallower Chukchi Sea is stratified, which would make conditions more conducive to the formation of subsurface plumes (Rudels et al., 1991; Rye, Brandvik, and Strom, 1997). Meanwhile, water temperatures in the shallow Chukchi Sea are similar to the deepwater temperatures in the Gulf of Mexico, suggesting the Chukchi could support similar levels of hydrocarbon (including methane) degradation. Both methane and petroleum hydrocarbon degraders are present and active in the Chukchi Sea (and in the Arctic in general) ice, water, and sediment (Gerdes et al., 2005; Damm et al., 2007; Atlas, Horowitz, and Busdosh, 1978; Braddock, Brannon, and Rasley, 2004). Differences between the Gulf of Mexico and the Chukchi Sea in seasonality, weather and wind patterns, sea ice, and surface water temperatures also make extrapolations from the DWH blowout and a hypothetical blowout in the Chukchi Sea problematic.

The following subsections describe the types of effects that could occur during each Phase of the VLOS scenario.

Phase 1 (Initial Event)

The initial blowout event could impact water quality via the release of natural gas. When natural gas (primarily methane) is released into the water, it rises through the water column as a function of pressure and temperature. When released in a blowout or rupture at depth, the quality of the water would be altered temporarily and in deeper, colder waters some of the natural gas enters the water as a water-soluble fraction. Upon reaching the surface the gaseous methane would react with air, forming water and carbon dioxide (CO_2), which would then disperse into the atmosphere. The near-surface water quality would have higher concentrations of CO_2 than is natural and could therefore affect processes and reactions in the microlayer at the water-air interface, such as egg and larvae respiration (GESAMP, 1995).

Phase 2 (Offshore Spill)

Hydrocarbons spilled into the sea can behave in several ways depending on the types of hydrocarbon compounds in the mix and the depth and temperature at which the spill occurs. Hydrocarbons can volatilize into the air, dissolve into the water column or water surface, oxidize via ultraviolet radiation or microbial activity, or emulsify and float or sink to the subsurface, depending on the water uptake plus initial density of the spilled oil (National Research Council, 2003c).

Oil moves through the water in horizontal and vertical directions. This movement of oil occurs through several processes including spreading, dispersion, advection (tides, current, Langmuir circulation), entrainment, deposition to seafloor sediments, re-suspension from seafloor, uptake and excretion by biota, and stranding on shorelines. Waves and winds can mix oil droplets on the surface into subsurface waters. The various mechanisms by which oil moves in seawater is also influenced by the type and degree of sea ice present and the location of the spilled oil (on the water, under the ice, encapsulated in the ice or on top of the ice).

The more volatile compounds in an oil slick, particularly aromatic volatiles, are usually the most toxic components of an oil spill. In-situ, cold-water measurements (Paine and Levin, 1981, 1982, 1985; Payne et al., 1984a,b) have demonstrated that concentrations of individual components in an oil slick decrease significantly in concentration over a period of hours to tens of days.

The highest dissolution rates of aromatics from a slick occur in the first few hours of a spill and accumulate in the underlying water (Paine and Levin, 1981). By the time dissolved oil reaches depths of 10 m in the water column, it becomes diluted and may spread horizontally over about 10,000 m. The slick would become patchy, with the total area—containing widely separated patches of oil—stretching orders of magnitude larger than the actual amount of surface area covered by oil.

A small portion of the oil from a surface 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, where suspended sediment loads are generally lower, only about 0.1% of the crude would be incorporated into sediments within the first 10 days of a spill (Manen and Pelto, 1984).

An offshore spill could create tarballs. One study of spilled oil with a slightly heavier composition than analyzed in this VLOS scenario indicated that about 68% of the spilled oil could persist as individual tarballs dispersed in the water column 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 (Butler, Norris, and Sleeter, 1976, as cited in Jordan and Payne, 1980). During the slow process of sinking, as the oil drifts over hundreds or thousands of kilometers, sunken tarballs would be widely dispersed in the sediments, resulting in widespread distribution but relatively lower concentrations in any one area of sediment.

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 (Barsdate et al., 1980). In marine waters, advection and dispersion would reduce the effect of release of toxic oil fractions or their toxic degradation products, including products resulting from photo-oxidation. Isolated waters of embayments, shallow waters under thick ice, or a fresh spill in rapidly freezing ice, however, would not be exposed to this advection and dispersion.

An oil spill that occurs in broken-ice or under pack ice during the deep Arctic winter would freeze into the ice, move with the ice and melt out of the ice the following summer. 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.

Phase 3 (Onshore Contact)

If oil contacted a shoreline, mixed into the shoreline, and then dispersed, elevated concentrations of hydrocarbons could occur in the water and sediments offshore of the oiled shoreline.

Phase 4 (Spill Response and Clean-up)

Dispersants

Dispersants are a combination of surfactants and solvents that work to break surface oil into smaller droplets which then disperse on the surface and into the water column. Many factors affect the behavior, efficacy, and toxicity of a particular dispersant, including water temperature, surface salinity, wave and wind energy, light regime, water depth, type of oil, concentration of dispersant, how the dispersant is applied (constant or intermittent spikes), and exposure time to organisms. Dispersants are used to degrade an oil spill more quickly through increasing surface area and to curtail oil slicks from reaching shorelines (Word et al., 2008).

As oil breaks into smaller droplets it can distribute vertically in the water column. If oil droplets adhere to sediment, the oil can be transported to the seafloor and interstitial water in the sediment. In shallow nearshore waters, wind, wave and current action would more likely mix the dispersant-oil mixture into the water column and down to the seafloor environment. The water toxicity effects of dispersant application in a VLOS in the Chukchi Sea would be similar to the effects outlined above under Phase 2. Chemically dispersed oil is thought to be more toxic to water column organisms than physically dispersed oil, but the difference is not clearcut, and generally the toxicity is within the same order of magnitude (National Research Council, 2005b).

In-Situ Burning

In-situ burning is used to reduce an oil spill more quickly and to curtail oil slicks from reaching shorelines. In-situ burning could increase the surface water temperature in the immediate area, and produce residues. The upper-most layer of water (upper millimeter or less) that interfaces with the air is referred to as the microlayer. Important chemical, physical and biological processes take place in this layer and it serves as habitat for many sensitive life stages and microorganisms (GESAMP, 1995). Disturbance to this layer through temperature elevation could cause negative effects on biological, chemical, and physical processes.

Residues from in-situ burning can float or sink depending on the temperature and age of the residue. Floating residue can be collected; however, residues that sink could expose the benthic waters and sediment to oil components as the residue degrades on the seafloor.

The NOAA Office of Response and Restoration states, "Overall, these impacts [from open water in-situ burning] would be expected to be much less severe than those resulting from exposure to a large, uncontained oil spill" (DOC, NOAA, 2011a). If an oil spill occurred in winter, in-situ burning would be limited by the lack of open water to collect oil and open water in which to burn it. If burning could occur in winter on a limited scale, sea ice would melt in the immediate vicinity of the burn.

Offshore Vessels and Skimmers

Vessels can affect water quality through deck drainage, sanitary and domestic discharges, brine and cooling water discharges, small spills, anchoring in benthic habitat, disturbance of microlayer and potential for introduction of invasive species from foreign or out-of-state vessels. In winter, ice-breakers could affect the movement of spilled oil that may be trapped beneath or in the ice. Vessel discharges are permitted by USEPA under the Vessel General Permit. The effects of vessels on water quality are described in detail in the Sale 193 FEIS (USDOI, MMS, 2007a).

Drilling of Relief Well

Drilling an emergency relief well would entail discharge of drilling muds and cuttings. These discharges are regulated by the USEPA under NPDES General Permit 280000, Oil and Gas Exploration in the OCS. There is potential for accidental spills and potential for introduction of invasive species from vessels or equipment placed overboard. Drilling of a relief well would cause an increase in suspended sediment and turbidity in the water column and potential increase in contaminants in the water and sediments. The effects on water quality from well-drilling are described in detail in the Sale 193 FEIS (USDOI, MMS, 2007a).

The current Arctic National Pollutant Discharge Elimination System (NPDES) General Permit for wastewater discharges from Arctic oil and gas exploration expired on June 26, 2011. EPA will reissue separate NPDES exploration General Permits for the Beaufort Sea and the Chukchi Sea prior to the 2012 drilling season. EPA expects that tribal consultation and public comment on the new proposed Arctic oil and gas exploration permits would occur in Fall 2011.

Beach Cleaning and Booming

The cleaning up of oiled beaches (and booming and rescue of oiled animals) could entail small boat and aircraft landings on marine and freshwater shorelines and waters; large numbers of people walking and wading through aquatic habitats; collection of oiled sediment and beach wrack; possible booming of coastal waterways; possible hydraulic washing with hot water; possible application of fertilizer to enhance degradation of oil; and possible raking of fine sediments.

These activities could result in effects from suspended sediment in waters and resettlement of sediments elsewhere, possible resuspension of hydrocarbons, runoff of treatment-laden waters that could affect nearshore temperature and nutrient concentrations, removal of beach wrack nutrient sources from intertidal zones, and potential for introduction of invasive species from small boats as well as waders and clothing worn by workers from outside of the Alaska Arctic region.

Phase 5 (Long-term Recovery)

During long-term recovery, there could be reoccurring visitation by monitoring and research personnel, which could result in the same sort of effects encountered during beach cleaning.

Over the long-term, contamination of aquatic environments from oil (and possibly dispersant residue on the seafloor) leaching would continue from sedimented and resuspended oil, and from possible resuspension of polycyclic aromatic hydrocarbons (PAHs). Sunlight (UV radiation) increases the toxicity of leached PAHs, so summer sunlight in Arctic Alaska could exacerbate the amount and degree of toxicity.

Oil Spill Trajectory Analysis

A 2.2 MMBbl oil spill would cause significant impacts to water quality no matter which portion of the Chukchi Sea it originated in and no matter which time of year it occurred.

The daily spill sizes range from approximately 60,000 bbl to 20,000 bbl per day over the life of the VLOS, and weathering estimates were calculated for these two spill sizes, assuming no spill response for summer and winter conditions. Approximately 30% of a 60,000 bbl oil spill during summer would remain in the water column, in bottom sediments, ingested by biota or beached within 30 days (Appendix B, Table B-4). It is estimated that within 30 days in a summer spill, 33% of the oil spill would disperse and 37% would evaporate (Appendix B, Table B-4). Within 60 days after a very large oil spill in summer, it is estimated that between 245,800 and 364,200 km^2 of discontinuous ocean surface would be contacted by oil trajectories from Launch Areas 1-13. The greatest discontinuous ocean surface area contacted would be generated by LA 8; the least by LA 9 (Appendix B, Table B-5).

It is estimated that approximately 48% of a hypothetical 60,000 bbl crude oil spill during winter would remain on the water surface, in bottom sediments, ingested by organisms, or beached within 30 days. It is estimated that 15% of the oil spill would disperse and 37% would evaporate within 30 days in winter melt-out spill (Appendix B, Table B-4). Within 360 days after a VLOS in winter, it is estimated that between 368,400 and 507,200 km^2 of discontinuous ocean surface would be contacted by oil trajectories from Launch Areas 1-13. The greatest discontinuous ocean surface area contacted would be generated by LA 4; the least by LA 3 (Appendix B, Table B-6).

It is estimated that between 0 and 1,368 km of discontinuous shoreline length could be contacted by oil trajectories in the Chukchi Sea depending on the location of a VLOS, the season, and the number of days after the spill release (see OSRA model results in Section IV.C.4-Fish). The type of shoreline that would be contacted along the Chukchi coast includes salt and brackish water marshes, mixed sand and gravel beaches and fine to medium sand beaches (NOAA-ORR, 2011).

Conclusion

A very large oil spill and gas blowout would present sustained degradation of water quality from hydrocarbon contamination in exceedence of State and Federal water and sediment quality criteria. These effects would be significant. Additional effects on water quality would occur from response and cleanup vessels, in-situ burning of oil, dispersant use, discharges and seafloor disturbance from relief well drilling, and activities on shorelines associated with clean-up, booming, beach cleaning, and monitoring.

The selection of Alternative III or IV (coastwise corridor deferrals), which removes parts of Launch Areas 8-13 from the Lease Sale area, could reduce the chance of a very large spill from contaminating nearshore, estuarine, intertidal, and riverine waters. The larger deferral associated with Alternative III has greater potential to reduce nearshore impacts as compared with Alternative IV. The effects of degradation of offshore water quality would not be reduced under either Alternative III or IV.

IV.E.3. Air Quality

A very large oil spill (VLOS) event, initiated by an explosive blowout, would release potentially harmful emissions into the atmosphere, particularly those pollutants regulated under the Clean Air Act (CAA). Pollutants regulated under the CAA include nitrogen dioxide (NO_2), carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter (PM_{10} and $PM_{2.5}$), and would also include volatile organic compounds (VOC). Following the initial explosion, emissions would occur during each phase of the event due to fires (including in-situ burning), evaporative emissions from the oil, and emissions from sources operating during the oil spill recovery and clean-up process. The behavior of emissions released into the atmosphere over the Chukchi Sea, should a VLOS occur there, would be influenced by the Arctic climate as well as the severity of the oil spill and the characteristics of the pollutant sources. The Arctic climate is highly variable by season, is influenced by the polar maritime characteristics of the Arctic Ocean, and reflects the polar continental characteristics of the large adjacent Alaskan land mass. Meteorological conditions, such as temperature inversions, wind, and precipitation, define the atmospheric stability of the area and dictate the amount of turbulence and mixing that can occur. Thus, these parameters affect the build up of emissions and concentration of harmful pollutants that could threaten human health and wildlife. Therefore, the severity of impacts to air quality from a VLOS would depend largely on whether the spill occurs in the winter or in the summer. As explained in the following subsections, an oil spill or oil spill recovery occurring during the winter would likely result in greater impacts to air quality than a spill occurring during the summer.

Winter Spill

Weather conditions in the Arctic winter are dominated by the Siberian high pressure system over central Russia, and by the semipermanent Aleutian low, which resides over the Bering Sea (Ahrens, 2009). Air within a high pressure system has a tendency to rotate clockwise and the heavy cold air has a tendency to flow down and away from the pressure center creating cold dry conditions defined as stable air. Conversely, air within a low pressure system has a tendency to lift, is buoyant, and rises counterclockwise toward the center of lower pressure causing precipitation and unstable conditions. The interaction of these two systems results in light to moderate (5 to 18 miles per hour) east to northeast winds with episodes of strong breezes (25 miles per hour) from the east during storms. Higher winds have a tendency to peak during October through December and there is little to slow down the wind over open water (Veltkamp & Wilcox, 2007).

There are episodes of much lighter winds during frequent winter temperature inversions. An inversion is a surfaced-based phenomenon that occurs in stable air where a colder layer of air is ‘capped’ from above by a layer of warmer air. Inversions are characterized by relatively low wind speeds that restrict the dilution and mixing of pollutants with the surrounding air (Ahrens, 2009). The layer of air within a temperature inversion, particularly shallow layers like those associated with the Siberian high, is compressed close to the surface. Therefore, harmful emissions are confined within a shallow layer increasing pollutant concentrations and the severity of air quality impacts.

Wind will transport pollutants away from a source, so the most severe impacts to air quality would occur in the immediate vicinity of the source and further downwind from the source region. Thus, the most severe wintertime impacts from a VLOS occurring within any of the hypothetical launch areas would most likely occur downwind along the northwest coastline of Alaska, from Barrow to Point Hope. There would be few impacts to the northeast coast of Alaska.

The infrequent occurrence of winter precipitation, which has a tendency to deplete the atmosphere of some pollutants, would do nothing to decrease the accumulation of emissions. Therefore, a VLOS occurring during the Arctic winter would likely result in more severe impacts to air quality conditions than under summer conditions.

Summer Spill

During summer months, the Arctic experiences less frequent surface-based temperature inversions and more frequent precipitation. When they do occur, inversion layers are deeper, allowing unrestricted mixing and dilution of pollutants with the surrounding air, while precipitation tends to remove some pollutants from the atmosphere. This results in lower pollutant concentrations that have less of an impact on air quality conditions.

Summer Arctic weather is driven by two semipermanent pressure systems, the Icelandic low over Greenland and the Pacific high positioned in the Gulf of Alaska (Ahrens, 2009). The interaction of these two systems results in northwest winds over the Arctic in summer. Breezes are moderate, averaging 12 to 18 miles per hour, with higher winds during storms. There could be four to six storms a month over the Arctic increasing the precipitation over the sea and over land (NSIDC, 2000).

The windy rising air and precipitation destabilize the lower atmosphere allowing dilution and mixing of pollutants. Gaseous pollutants rise with the surrounding air and are caught up in higher steering winds that allow maximum dispersing of pollutants. Consequently, the most severe summertime impacts from a VLOS would likely occur within launch areas (LA) 1 through 6, and LA 9 through 12, where northwest winds would drive pollutants over Alaska's northwest coastline. Less severe impacts would occur from LA 7, 8, and 13, where northwest winds would direct pollutants generally parallel to the northeast coastline.

Black Carbon

The burning of fossil fuels creates particles of soot that are carried away by the wind from the source. Referred to as black carbon (BC), the particles are deposited on local and regional surfaces surrounding the source of burning. Accumulation of BC would be expected primarily following the initial oil well explosion and to a lesser extent, following in-situ burning. Should a VLOS occur in the Chukchi Sea, BC particles would likely settle on nearby areas of exposed sea ice and would be transported and deposited over nearby land.

The presence of BC on ice and snow surfaces has a warming effect on the atmosphere because the blackness of the carbon absorbs heat, inhibits the reflective properties of the ice and snow, and accelerates melting of sea ice and land ice and snow. This is referred to as radiative forcing. When incoming solar radiation equals the reflected outgoing energy from the earth, the earth-atmosphere system is in radiative equilibrium. When the reflective characteristics of the earth's surface decreases, such as occurs when BC is deposited on ice and snow, the equilibrium is shifted and there is more incoming energy than outgoing energy. Thus, the system experiences radiative forcing, or warming (Ahrens, 2009).

Shindell and Faluvegi (2009) suggest that a constant presence of BC is necessary for consistent radiative forcing to affect climate change. Also, particles of BC have a relatively short atmospheric life span of less than a week (Bice, Eil, Habib, Heijmans, Kopp, Nogues, Norcross, Sweitzer-Hamilton, & Whitworth, 2009). When also considering the BC sources from a VLOS are temporary, and deposits over ice and snow would diminish following melting, BC deposits would be temporary, short-term, and local. The presence of BC would be experienced primarily following a VLOS that occurs in the winter. The deposit of BC, should a VLOS occur in the summer, would be mitigated by the increased occurrence of precipitation and the decreased presence of ice and snow. Additional information relating to black carbon is included in the air quality section of the Sale 193 FEIS (USDOI, MMS, 2007a).

Phase 1 (Initial Event)

The initial explosion of gas and oil due to a VLOS would result in a large black smoke plume containing PM and the other products of combustion, such as NO_x, SO_x, CO, VOC, and CO_2. The fire could also produce polycyclic aromatic hydrocarbons (PAHs), which are known to be hazardous to human health. In particular, the intense heat of the fire would elevate the level of NOx emissions, and concentration of PM in the initial smoke plume would have the potential to temporarily degrade visibility in the immediate area and in any affected Prevention of Significant Deterioration (PSD) Class I areas and other areas where visibility is of significant value.

The heat of the fire would immediately cause the pollutants within the plume to disperse in an upward buoyant flow. The location of high pollutant concentrations due to the smoke depends on the stability of the atmosphere at the time of the explosion. Should the VLOS occur during winter months, the upward transport of the pollutants could be constrained by fumigation conditions limiting dilution and mixing with the surrounding air, and restricting transport by the wind. In this case, pollutant concentration levels at nearby locations would likely reach levels that exceed the Federal and State thresholds that define impacts as significant. Otherwise, the rising plume of pollutants would become diluted with height and surface concentration levels would not be as high in the immediate vicinity of the fire (Evans, Walton, Baum, Mulholland, & Lawson, 1991). In either case, over time the smoke would be transported by the wind and would eventually affect surface areas at a distance from the fire. The initial fire could burn for up to two days and the pollutants of concern would include PM, black carbon, and VOC. It would be during this initial event when the majority accumulation of BC would occur. The deposits would be more severe if the initial explosion were to occur in the winter when the maximum amount of sea ice and land ice and snow are present. Also, BC would be more likely to reach the shoreline if the VLOS were to occur in LAs 9 through 13. Emissions of VOC would be high during Phase 1 due to evaporation of freshly surfaced oil. A laboratory analysis of oil spilled during the *Deepwater Horizon* (DWH) event showed the first 23 percent of the oil evaporated within the first two hours following the initial explosion. During this time, the emissions of VOC were confined to a relatively narrow plume as the sea surface transport of oil did not exceed a few kilometers (de Gouw, Middlebrook, Warneke, Ahmadov, Atlas et al., 2011). Consequently, the VOC impacts would be most severe immediately following the explosion and decrease as the oil slick spreads. With increasing distance from the location of the fire, some of the gaseous pollutants, particularly VOC, would undergo chemical reactions resulting in the formation of secondary organic aerosols, which are mostly semi-volatile organic material.

Computer modeling conducted to evaluate emissions from a large oil spill considered several different VOC and other compounds, including benzene, ethylbenzene, toluene, and o-xylenes, which are classified by the USEPA as hazardous air pollutants (HAP). The results showed that these compounds vaporize almost completely within a few hours following a spill. The ambient concentrations would peak within the first several hours after a spill and would be reduced by two orders of magnitude after about 12 hours. The heavier compounds would take longer to vaporize and may not peak until about 24 hours after spill occurrence. Additional information of air quality impacts from oil spills is included in the air quality section of the Sale 193 FEIS (USDOI, MMS, 2007a).

Air quality impacts would be expected to be more severe during Phase 1 if the VLOS were to occur during winter months when fumigation conditions are more likely and precipitation is less frequent. Consequently, the Phase 1 fire and spread of surface oil would cause moderate to major impacts from PM and VOC emissions, especially in the vicinity of the explosion. With distance from the fire and with further spreading of surface oil, the concentrations of VOC would be less severe but moderate impacts could still occur along the northwest coastline.

Phase 2 (Offshore Oil)

Impacts from this phase of the VLOS will continue until the sea is clear of all or most of the oil. As long as there is an oil slick on the sea surface there will be evaporative emissions and some level of air quality degradation until most volatile hydrocarbons are depleted from the oil. As such, impacts from this phase would occur simultaneously and in combination with the impacts occurring during Phase 3, 4, and 5.

Evaporation contributes to weathering of the oil, the natural chemical and physical processes that lead to the disappearance of oil from the sea surface. However, the rate of evaporation differs depending on volatility of the oil and increases with higher temperatures. Higher temperatures also allow an oil slick to spread more quickly, thinning out the layer of oil, and decreasing the emissions of VOC. Evaporation decreases the oil's toxicity because the lighter more toxic hydrocarbons dissipate. Fifteen to 30 percent of the oil could evaporate within the first 30 days, depending on the season (Polar Research Board, 2003).

Evaporative emissions of VOC will combine with aromatic volatile compounds, and some HAP emissions. During the *Deepwater Horizon* event, air samples were collected through the inter-agency efforts of British Petroleum (BP), Occupational Safety and Health Administration (OSHA), and the U.S. Coast Guard. The samples showed concentration levels of HAPs, such as benzene, toluene, ethyl benzene, and xylene to be below the OSHA Occupational Permissible Exposure Limits (PEL) and the more stringent ACGIH (American Conference of Governmental Industrial Hygienists) Threshold Limit Values (TLVs) (U.S. Department of Labor, 2010). However, even in low concentrations, some HAPs emissions may be hazardous to personnel working in the vicinity of the spill site, which could be reduced by monitoring and using protective gear, including respirators.

Concentrations of pollutants depend largely on the volume of the oil over the sea surface and wind conditions in the vicinity of the oil slick. As a general rule emissions of VOC would be highest at the source of the spill because the rate of evaporation depends on the volume of oil present at the surface. However, with time the emissions will decrease because even if the oil were not recovered, VOC concentrations would decrease as the surface oil area increases and gets thinner through transport by the current. This phase of the VLOS could continue for months so that emissions will eventually disperse in the wind even allowing for frequent temperature inversions during winter when winds are very light. Average wind speeds over the Arctic are sufficient to disperse the pollutants over such a long period of time. Air quality impacts could be major in the areas where oil is thick over the sea surface, which would likely be at the beginning of Phase 2 and could occur during a winter VLOS. However, impacts are expected to be minor to moderate as time goes by and the oil slick decreases.

Phase 3 (Onshore Contact)

As the spill nears shore, evaporative emissions from the sea surface oil slick would continue to occur as described under Phase 2. As such, a portion of the most volatile hydrocarbons would have evaporated by the time the oil reaches the shoreline. Therefore, potential for harmful VOC emissions would depend on the remaining volatility of the oil and the thickness of the oil accumulating on the shore. Combined with the other effects of weathering, such as dissolution and dispersion, further harmful emissions from the oil would likely be limited.

Once the oil is onshore, even minor emissions could cause short-term human effects. The emissions may cause temporary eye, nose, or throat irritation, nausea, or headaches, but the doses are not thought to be high enough to cause long-term harm (U.S. Environmental Protection Agency, 2010). Conversely, responders could be exposed to levels higher than the permissible exposure levels (PEL) established under the Occupational Safety and Health Administration (OSHA) guidelines (U.S. Department of Labor, 2010). During the *Deepwater Horizon* event, 15,000 air samples collected near shore by BP, OSHA, and the U.S. Coast Guard (USCG) showed most levels of benzene, toluene, ethylbenzene, and xylene were under detection levels. Among the many samples taken by BP, there was only one indicating benzene exceeded the OSHA PEL (USDOI, BOEMRE, 2011: Appendix B, Section 4.1.1.1). All other sample concentrations were below the more stringent American Conference of Governmental Industrial Hygienists (ACGIH$_{®}$) threshold limit values (TLVs) (U.S. Department of Labor, 2010). All measured concentrations of toluene, ethylbenzene, and xylene were within the OSHA PELs and ACGIH TLVs.

The impact of VOC emissions from oil collecting onshore would be negligible to minor, short-term, and not expected to cause permanent harm. However, responders are at risk for exposure to harmful levels of benzene and should take safety precautions to avoid exposure.

Phase 4 (Spill Response and Cleanup)

The sheer volume of petroleum estimated for release during a VLOS would require an array of spill response and cleanup techniques and strategies. No longer concerned primarily with VOC emissions, efforts during this phase of the VLOS event would engage new sources of emissions, such as dispersants, in-situ burning, and the use of offshore vessels. To support these efforts requires the use of aircraft and surface vehicles, which also produce potentially harmful emissions.

Dispersants

The use of dispersants and in-situ burning are the two non-mechanical techniques used most commonly in response to an oil spill. Dispersants and in-situ burning focus on changing the characteristics of the oil within the environment rather than using mechanical equipment (physical containment and recovery equipment, such as booms and skimmers) to recover or remove the oil (Ocean Studies Board, 2005). Dispersants, which may be applied by marine vessels or by aircraft, are chemical agents, such as surfactants, solvents, and other compounds, that break up the oil slick by decreasing interfacial tension between water and oil. The result is small oil droplets that do not merge with other droplets. The droplets stay suspended in the water column and are transported by waves. The objective of using a dispersant is to transfer oil from the sea surface into the water column (Ocean Studies Board, 2005). While the use of dispersants can decrease the size of the oil slick, toxic emissions are possible from the chemicals and solvents used in dispersants that could be potentially harmful. Following the DWH event, the USEPA mobilized the Trace Atmospheric Gas Analyzer (TAGA) buses that are self-contained mobile laboratories that conduct air quality monitoring (USEPA, 2011a). The EPA conducted monitoring for two chemicals in dispersants that have the greatest potential for air quality impacts: EGBE (2-butoxyethanol) and diproplyene glycol monobutyl ether. The TAGA analysis detected levels of the chemicals in the air along the Gulf Coast that were below the threshold that would be likely to cause adverse health effects. Consequently, EPA suggests that using dispersants for oil spill cleanup would cause negligible impacts on air quality (USEPA, 2011b).

In-situ Burning

In-situ burning (ISB) is controlled burning of oil intended to decrease the volume of sea surface oil after an oil spill. Burning the oil results in emissions of NO_2, SO_2, CO, VOC, and CO_2 within a plume of black smoke. Monitoring studies of controlled oil burning at sea showed levels of NO_2, SO_2, and CO were below detection levels (Fingas, Ackerman, Lambert et al., 1995). The study found that VOC emissions were below levels detected from the unburned oil and PAH were not at a level considered harmful. Results of smoke-plume modeling showed concentrations of PM did not exceed the health criterion of 150 mg/m3 when measured three miles downwind of the burning (USDOI, BOEMRE, 2011). Considering the low concentrations of pollutants found in monitoring and modeling, and the short-term nature of in-situ burning, the air quality impacts would be minor. Additional information of air quality impacts from in-situ burning is included in the air quality section of the Sale 193 FEIS (USDOI, MMS, 2007a).

Offshore Vessels

Offshore vessels would be used to remove oil from a spill at sea, apply dispersants, and to drill a new well. The oil-skimming vessels use devices to skim oil off the surface of the water, such as belts, disks, tubes, and suction devices. A VLOS may require up to 1,600 diesel-powered oil-skimming vessels, and other marine equipment such as ice breakers, over the course of time required to confine and remove oil from the surface. It is a time-consuming process that would likely take weeks or months to complete and would result in thousands of tons of emissions, particularly NO_2, but also including CO, PM, SO_2, VOC, and CO_2 (Discovery News, 2010; USEPA, 1996). Emissions from this number of vessels would likely result in temporary major air quality impacts.

Aircraft and Surface Vehicles

A portion of dispersants used to decrease the size of the oil slick may be applied using aircraft. During the response and cleanup process other aircraft may be needed for personnel and equipment transport, including helicopters, small piston-powered aircraft, and large commercial jets. Aircraft emissions depend partly on the physical characteristics and performance parameters of each unique aircraft type. These include the airframe type, the type and number of engines, takeoff weight, and approach angle. In addition to the physical characteristics of the aircraft operating at the site, emissions further depend on the time that each aircraft type operates in the various modes that define a landing and takeoff cycle. A landing and takeoff cycle (LTO) consists of the approach, landing roll, taxi to and from the parking area, idle time, takeoff, and climbout. In addition to aircraft, surface-based vehicles are necessary.

Phase 5 (Long-term Recovery)

Following the removal or other disposition of the oil by burning, evaporation, or weathering, few, if any, additional recovery efforts would be required relative to air quality impacts. However, during the long-term recovery process, there would be a continued presence in the area of the VLOS and the affected areas onshore. In order for this recovery effort to proceed on a long-term basis, the continued use of marine vessels, small boats, aircraft, and surface vehicles will be required. Emissions from these sources would be far below the levels experiences during any of the previous phases of the VLOS. Considering the decrease in pollution sources and the meteorological conditions existing over the Arctic, particularly the potential for Arctic winds to disperse air pollutants, the expected air quality impacts during this phase would be considered minor.

Oil Spill Trajectory Analysis

The types of impacts to air quality discussed above would be expected to occur regardless of the location of the spill's source. An oil spill trajectory analysis is not provided.

Conclusion

A VLOS in the Chukchi Sea could emit large amounts of regulated potentially harmful pollutants into the atmosphere. This will cause major air quality impacts during some phases of the event. The greatest impacts to air quality conditions would occur during Phase 1 and Phase 4, particularly if the spill occurs in the winter. Impacts continue for days during Phase 1 but could continue for months under Phase 4. Therefore, while the impacts are estimated to be major during these two phases, the emissions from the VLOS would be temporary and over time, air quality in the Arctic would return to pre-oil-spill conditions. These impacts are not anticipated to vary under Alternatives III or IV.

IV.E.4. Lower Trophic-Level Organisms

This section assesses the potential for the hypothetical VLOS scenario described in Section IV.D to impact the lower trophic organisms found within the physical environment of the OCS in the Chukchi Sea planning area and shoreward zone Alaska State waters. This physical environment is described in the Sale 193 FEIS (USDOI, MMS, 2007a), and the effects of a large oil spill are described in the Sale 193 FEIS and the Arctic Multi-Sale Draft EIS (USDOI, MMS, 2008a). These descriptions are incorporated here by reference.

Lower trophic and benthic populations in the Chukchi Sea could be strongly impacted by a VLOS, with a same-season to one-year loss of major proportions to all components of known lower trophic communities. In all phases of a VLOS, one or more of the lower trophic communities described in this section would be affected by the byproducts of oil created by natural and anthropogenic processes. Furthermore, many lower trophic organisms have the capacity to accumulate oil and oil toxins if they are not killed outright, thereby leading to bioaccumulation and biomagnification in upper levels of the foodweb (Neff, 2002; Newman and Clements, 2008). In particular, this includes copepods and other crustaceans (Hansen et al., 2011; USDOI, MMS, 2004).

This lower trophic section will define and describe in brief the potentially affected communities of lower trophic organisms, summarize pertinent information from the above documents concerning the effects of a VLOS on lower trophic organisms, and describe effects on lower trophic communities resulting from each of the five phases of a hypothetical VLOS as described in Section IV.D of this document.

Phase 1 (Initial Event)

The initial explosive blowout and ensuing fire proposed in the VLOS scenario would result in two separate impact producting contexts, one of subsurface explosion and potential fire at the wellhead and the other of fire at the drilling rig above the water surface. Each of these is discussed in turn:

Explosion and Fire at Wellhead

An explosion and ensuing fire created by natural gas at the wellhead would result in an increase of pressure and temperature of the immediate environment. Near instantaneous changes in the chemical composition of the surrounding environment in the form of heat energy, followed by gas and oil being released to the surrounding sea water would initiate the release of oil to the water column. Severity of effects would be dependent upon released energy. The explosion and chemical changes in the water column would result in the loss of pelagic and epibenthic lower trophic organisms in the near vicinity of the well head. A localized event at that stage of the timeline would likely not cause effects at a population level. Sediment upheaval and re-distribution of sediments into the water column and their subsequent deposition on the seafloor could affect pelagic organisms within the plume and all benthic organisms buried by the sediments, respectively. The severity of the cumulative effects would depend on the force of the explosion, concentration within the water column, density of ejected sediments, and duration of the sediment plume within the water column before deposition to the sea floor.

Fire at Drilling Vessel – Above Surface

A fire at the surface on the rig would create localized effects on plankton populations due to heat of the fire and release of material as a result of the event, including oil, melting plastics and rubbers, and chemicals used by response crews in attempting to control the fire on the rig. Should the sinking of an oil rig occur this could potentially have the greatest effect on lower trophic organisms at all community levels. This event would create a separate oil plume as it sank. The final location of the rig on the sea floor could create further disturbance of the benthos and likely create a separate source of oil plumes in the water column. Overall, the cumulative effects of this first phase would likely not affect the lower trophic communities at a population level.

Phase 2 (Offshore Oil)

Oil is highly toxic to organisms with a small body size. Phytoplankton, zooplankton, and other lower trophic organisms are in contact with their aqueous environment through thin layers of membranous tissue, have short distances between those layers and internal organs, and rapid metabolic rates (Jiang et al., 2010; Newman and Clements, 2008; Suter, 2007). The smallest developmental stages of organisms with complex life cycles, such as the nauplii larvae of copepods and other crustaceans, are especially vulnerable to those effects (Hanson et al., 2011; USDOI, MMS, 2004). The complex physical environment of the Chukchi Sea creates unpredictable advective pathways and changes the relative positioning of pycnoclines (density gradients) that separate sub-surface water masses. It also influences the movements of particle flow through the surface and subsurface pelagic environments (Belkin, Cornillon, and Sherman, 2009; Pickart et al., 2005). This makes the extent of effects dependent upon numerous factors, including duration and volume of spill, persistence and dispersion of oil in the water column and the benthic surface, chemical composition of the oil and where it has accumulated (at the water surface, in the water column, or at the benthic surface), the efficacy of chemical dispersants should they be approved and utilized, the depth and influence of pycnoclines (density gradients that influence the capacity of water masses to mix with one another) on the movement of oil through the pelagic water column, hours of daylight and UV intensity, seasonality and presence or absence of ice, how oil is incorporated into the ice during its formation, classification of ice, and presence or absence of polynyas and reaches. Potential effects of these factors on lower trophic populations are dependent upon their various combinations and include:

- Rapid accumulation of toxins within single cell algae and rapid death of these organisms within surface areas affected by oil slicks.
- If phytoplankton cell death does not instantly occur, drift and later ingestion by other organisms could lead to bioaccumulation at potentially large numerical scales.
- Although immediate effects of surface oil slicks could be serious to all affected components of neuston plankton populations, multi-year studies from previous oil spill events indicate population-level recovery should be relatively rapid (one year or less) in marine phytoplankton populations, particularly in productive waters of the Chukchi Sea.
- Populations of meroplankton (including instars, zooids, and nauplii; early larval developmental stages of numerous benthic and pelagic species) and adults of those species, depending upon factors listed above, may take one year or more to recover to pre-spill population levels if adults are affected by population-level losses from settling of oil on benthic surfaces.
- Results of experiments conducted on calanoid copepods indicated exposure to both sunlight and weathered Alaska North Slope crude oil resulted in mortality and morbidity (impairment of swimming ability and discoloration of lipid sacs) of 80-100% in test treatments of *Calanus marshallae*, while oil-only or sunlight-only treatments resulted in a 10% effect on mortality and morbidity.
- Adult copepods have a strong affinity for accumulation of PAC's within lipid storage vacuoles and an affinity to act as bioaccumulators of these toxins, enabling them to potentially be distributed by movements of water masses and affect upper level predators away from primary spill area.
- Studies carried out with larval benthic King crabs and seagrass shrimp exposed to 2 ppm crude oil showed >50% mortality in the first 6 hours of exposure.
- Pelagic communities including squid, jellyfish, ctenopohores, larvaceans, and pteropods are rarely affected by surface oil, but subsurface oil would affect these organisms and population effects would depend upon the area covered and persistence of oil in the water column. Use of dispersants could potentially negatively affect populations of these organisms, as knowledge of the efficacy of dispersants in cold water is limited.
- Benthic communities are affected by accumulation of oil at the ocean bottom, particularly when oil covers developing eggs and larvae of organisms that use the benthic surface for substrate attachment of these life stages, and when it penetrates the burrows of polychaetes, amphipods, and other organisms that create pathways through the upper surface layers of the benthic sediment.
- Likewise, epontic communities would similarly be affected by oil that accumulates under the subsurface of the ice, as many organisms live on that surface (i.e., concentrations of ice algae) and within the interstitial brine layers of the ice architecture.
- Persistence of oil through winter months to spring breakup could affect recovery and subsequent productivity of benthic communities, as ice algae in affected areas will not contribute to benthic productivity, and crustaceans (krill, for example) may not survive at

population levels adequate to compare with pre-VLOS contributions to the productivity of under-ice pelagic and benthic communities and spring plankton blooms.

- Presence of oil in water or ice could affect attenuation (penetration) of light through the water column and ice by way of absorption and scattering of solar radiation.
- Presence of oil within polynyas and reaches will affect the capacity of these open water biological hotspots to support algae and invertebrate populations that are sustained throughout the months of ice cover and contribute to benthic and pelagic productivity after the ice retreat.

(Barron, 2007; Barron et al., 2008; Brandvik and Faksness, 2009; Brodersen, 1987; Deibel and Daly, 2007; Iken, Bluhm, and Dunton, 2010; Hanson et al., 2011; Jiang et al., 2010; Newman and Clements, 2008; NRC, 2005; Suter, 2007; USDOI, MMS, 2003, USDOI, MMS, 2004, USDOI, MMS, 2008)

Phase 3 (Onshore Contact)

Onshore and nearshore environments of the Chukchi Sea are summarized in the Chukchi Sale 193 FEIS (USDOI, MMS, 2007), and an Environmental Sensitivity Index (ESI) shoreline classification of the Alaska Beaufort and Chukchi Seas study funded by the MMS (USDOI, MMS, 2003), both incorporated here by reference. State and Federal lands along the Chukchi Sea coastline include the Bering Land Bridge National Preserve, Cape Krustenstern National Monument, two segments of the Alaska Maritime National Wildlife Refuge, and the National Petroleum Reserve-Alaska. The Chukchi Sea shoreline features bays, inlets, lagoons, and barrier islands, with physical environments consisting of eroding thermokarst inclusions, wave and tidal undercut permafrost bluffs and peat shorelines, inundated lowland tundra, course-grained sand or cobblestone beaches, and estuaries of rivers and small streams along the shores (Hartwell, 1973; Taylor, 1981). Approximately 50% of the shoreline consists of permafrost overlaid with peat, interspersed with low-lying permafrost bluffs.

The Sale 193 FEIS describes locations and physical environments of kelp beds near Skull Cliffs and southeast of Wainwright. Neither the spatial extent nor diversity and abundance of these biological communities have been investigated. This is in contrast to the Boulder Patch, a well-studied kelp bed community located in Stefansson Sound in the nearshore Beaufort Sea (Dunton and Schonberg, 2000). Known locations of kelp beds are outside of the sale area but near potential gas pipeline routes. Studies by Dunton and Schonberg (2009) and Konar (2007) indicate the Boulder Patch kelp beds are slow to recover from disturbance. Dunton and Schonberg carried out experiments removing kelp from their holdfast attachment sites, after three years there was only a 50% recovery in the denuded patches. Suspecting invertebrate grazing as a factor, Konar repeated the experiment using cages to prevent access by potential herbivores and reported no recruitment after 2 years, again demonstrating the slow recovery rate of these communities. No experiments have been conducted on kelp bed communities in the Chukchi Sea. Other areas of special interest include the Ledyard Bay Critical Habitat Unit, used by endangered Spectacled Eiders as a molting area from July to November, and Kasegaluk Lagoon, a known bird, spotted seal, and beluga whale habitat (Frost, Lowry, and Carrol, 1993). These types of coastal marine environments, with intertidal and subtidal floral and faunal communities, would likely experience the longest term effects resulting from contact with oil (USDOI, MMS, 2003) and are discussed in Section IV.E.12.

As discussed in Section IV.E.1, the potential of a VLOS of 74 days duration projects a wide area of onshore exposure to weathered oil products, including the shorelines of the Chukchi Sea and the eastern shores of Siberia. Organisms inhabiting these diverse environments are subject to similar effects as those listed in the previous section, but some factors are specific to onshore contact. Among these are the affects of solar irradiance and the risks of photo-enhanced toxicity from oil in shallow water environments. Although this mainly refers to oil spills as opposed to drifting and previously weathered oil, it is of relevance to the intent of this section. The ultraviolet regions of solar radiation can substantially increase toxicity and risks of PAHs through photochemical modification of oil (Barron et al., 2008). A 2004 study funded by the MMS investigated persistence of PAH compounds in laboratory tests using shoreline soils collected from the Beaufort Sea, Port Valdez, and Cook Inlet areas. Through experimental work they concluded that some interactions between aromatic hydrocarbons and sediment organic matter may be irreversible, with field tests indicating they persist in all their collection areas from previous oils spills and natural seeps. River and creek delta areas exhibiting estuarine habitats would be adversely affected through wind and tidal exposure from oil, and the potential impact of storm events. In 1970, Reimnitz and Maurer (1979) observed the effects of tidal surges from a major storm event that inundated low-lying tundra and delta regions on the Beaufort Sea shoreline, leaving debris lines from flotsam as far as 5,000 m (16,500 ft) inland. A storm of equal or greater magnitude could force weathered oil far inward and leave residue over wide areas of tundra and river shores. The OSRA model estimates that 1–3 days of time could elapse before oil reaches the shoreline. The length and location of shoreline contacted depends on duration of the spill, The type of oil released in this scenario would likely be light weight crude, with a rapid evaporation time and low persistence. The OSRA model also states that for planning purposes, the USCG estimates 5%-30% of the spilled oil could reach shore, resulting in a large volume of oil potentially contacting environments that are slow to recover from disturbance. The effects to shoreward lower trophic communities would be reliant upon factors such as seasonality of spill, locations of onshore contact, and persistence of oil within the water before contact. The relatively low productivity of the near shore waters (Grebmeier et al., 2006) may influence the recovery rate for onshore populations. Effects to lower trophic populations where oil contacts the shore zone could result in one to several years for recovery, depending upon area of contact and duration and severity of exposure.

Phase 4 (Spill Response and Cleanup)

Spill response activities vary in their capacity to affect lower trophic populations. The efficacy of the application of dispersants is dependent upon water temperature, water density, energy from wind and waves, solar radiation intensity, and exposure time, or residence time, of the dispersant in an environment (NRC, 2005). The application of dispersants can cause sinking of droplets and subsequent aggregation on the benthic surface (Word et al., 2008; NRC, 2005) and increased exposure of small organisms to oil due to the increased surface area from small particles created by dispersants. In-situ burning would cause elevated surface temperatures and creation and introduction of residues into the water column (Buist, 2003), and disturbance of the surface layers of the ocean, including the microlayer that serves as a concentration point for many forms of plankton (Wurl and Obard, 2004). All activities requiring the use of watercraft will increase the disturbance of the lower trophic organisms and their habitats, particularly when these activities are carried out in nearshore environments. The length of time that response and cleanup activities continue will determine effects on lower trophic communities. In general, effects to phytoplankton and pelagic populations will likely be minor, but benthic and shore zone lower trophic populations could suffer greater effects of one or more years of recovery time.

Phase 5 (Long-Term Recovery)

Impacts affecting lower trophic organisms in long-term recovery are similar to the previously described scenarios. Phytoplankton populations should recover quickly due to the tremendous influx of phytoplankton and nutrients from the Bering Sea and Anadyr waters. Long-term and chronic effects will be most evident in populations of benthic and pelagic animals and organisms associated with kelp beds. Even with the advection of zooplankton through the currents of surrounding waters and the reproductive capacity of resident populations of benthic and pelagic invertebrates, the recovery of invertebrate populations may take 1-2 years if the impacting factors discussed in earlier sections should culminate in causing population-level effects to this diverse group of organisms.

Oil Spill Trajectory Analysis

The types of impacts on lower trophic level organisms discussed above would be expected to occur regardless of the location of the spill's source. An oil spill trajectory analysis is not provided.

Conclusion

A VLOS would likely have less than a one year effect on phytoplankton populations in the Chukchi Sea due to the influx of phytoplankton carried into the Chukchi Sea by the waters of the Gulf of Anadyr, the Bering Sea, and the Alaska Coastal currents that would supplement remaining endemic populations. However, short-term, local-level effects would have greater potential to affect local food webs. Severity of effects would be determined by duration of oil spill, weather patterns, and the resultant distribution and geographic coverage of surface oil slicks. Ice algae population effects would be determined by similar factors, as the presence of oil within polynyas and reaches, and if incorporated into first year ice would likely have at least a one-year effect on local populations due to effects on primary productivity and the probable inability of epontic communities reliant on ice algae to survive within oil-influenced ice.

Invertebrate populations within benthic, pelagic, and onshore environments are at greater risks from a VLOS due to their slower reproductive rate, longer life spans, and the potential of adult breeding populations being negatively affected by the VLOS and leading to a longer recovery rate. If population level effects resulting from a VLOS occur in breeding stocks of invertebrates of these Chukchi Sea environments, the recovery potential of populations would not be enhanced by the flow of Bering Sea and Anadyr waters as it is with phytoplankton populations. Phytoplankton and zooplankton populations extirpated by oil slicks that are constantly shifting and forming in new areas due to influences of wind, weather, and waves, would not be available to organisms that depend on them for food and survival. Food webs can be very short in the Arctic, with interactions between megafauna (i.e. whales, seals, walrus) and lower trophic organisms often comprising one or two trophic levels due to the tight benthic and pelagic coupling on the shallow continental shelf off the Alaskan Arctic coast (Dunton et al., 2005; Grebmeier et al., 2006). Bioaccumulation and biomagnification in these foodwebs is a concern. Long lived copepods (such as *Calanus glacialis*) may live 2-3 years, store lipids in the body cavity, undergo diapause (a form of hibernation), and be consumed by upper level predators (atlantic cod, bowhead whales, etc.) at a later date (USDOI, MMS, 2004). Toxicity studies carried out with benthic crabs and shrimp indicate they may not immediately die from toxins (living 24-96 hrs, depending on exposure and oil type), thus allowing greater opportunities for consumption by upper-level predators and biomagnification to occur (Brodersen, 1987). Phytoplankton themselves may not die immediately from the effects of exposure to oil; therefore, advective drift following bioaccumulation in their populations may allow them to be consumed by other organisms in locations away from contamination sites (Jiang et al., 2010). Recovery rates of one or more years may result from these effects on invertebrate populations.

These impacts are expected to occur to the same extent under each action alternative.

IV.E.5. Fish Resources

The Sale 193 FEIS and the Arctic Multi-Sale Draft EIS detail the effects of a large oil spill (USDOI, MMS, 2007a, 2008a) and are incorporated here by reference. The following text summarizes salient points on oil effects on fish from these two documents and adds new pertinent information that has come available since 2007. Common fish names are used within the text in this section; corresponding family and species binomial names are presented in the Appendix C, Table C-1.

Phase 1 (Initial Event)

An explosion would send percussive shock waves through the water, causing rapid increase in pressure, density and temperature in the immediate area of the explosion. Fish eggs, larvae and adults on the seafloor and in the water column would be injured or killed from shock waves from an explosive event when pressure, density and temperature rise rapidly in the immediate vicinity. The lateral lines and swim bladders of fish could be severely damaged. Fish injured by the explosion would have physical, physiological and behavioral effects that could interfere with swimming, feeding, reproduction and predator escape. Acute or chronic effects on fish from an explosion could carry into longer term effects on a population if a large proportion of the individuals were killed from a rare benthic community.

An explosion would damage benthic habitat and cause high levels of suspended sediment and turbidity, which in turn could affect fish gills and respiration. Visibility for fish would be affected by the turbidity in the immediate area.

Although most natural gas (primarily methane) quickly rises to the water surface, some can enter the water as a water-soluble fraction, especially at greater depths and pressures. In this case of a shallow water blowout scenario, most natural gas would reach the surface rapidly and pass through the water-air microlayer into the air. Important physical, chemical and biological processes occur in the microlayer (GESMAP, 1995) and fish occurring in that layer, particularly floating eggs and larvae, would be injured or killed. If a natural gas/oil blow-out occurred at the seafloor, benthic fish in the immediate area would be injured or killed. The type and severity of effects on fish would be dependent on the concentration of methane, the duration of exposure, the time of year (reproductive cycle), the species and life stage of fish and the presence or absence of sea ice.

A fire would cause the surface water temperature to rise immediately which would be lethal for epipelagic fish, eggs and larvae. Subsurface water temperature would increase more slowly and could cause changes in physiological processes, particularly for benthic fish that are more sedentary. If a fire continued and sub-surface temperatures continued to rise, subsurface egg and larvae mortality could occur over time. Free-swimming fish not obligated to a specific habitat would likely move out of the area if the temperature continued to rise. Chemical reactions in the water, such as oxygen concentration, would be altered by rising temperature and this could also affect the physiology of fish.

A drilling rig could physically impact the seafloor habitat if it sinks. Longer term impacts would occur if a drilling rig has materials that would leach into the near environment. In other places in the world, rigs in place appear to serve as structural habitat for some species of fish (Caselle et al., 2002). If the rig broke apart and drifted across the seafloor, there would be an alteration of the structural habitat of the seafloor.

Table C-1 (Appendix C) presents a summary of fish that occur in the Chukchi Sea and the environments they depend upon. In a VLOS explosion, demersal and pelagic fish would both be affected. The effects would differ somewhat if the explosion occurred at the seafloor (<50 m) or if it occurred along the riser (midwater pelagic) or at the surface of the rig (epipelagic environment). Sensitive life stages in the surface waters (such as floating eggs of Arctic cod and drifting fish larvae) would be particularly affected by the explosion (shock wave, methane) and fire (heat and chemical reactions). The freshwater stages of anadromous fish would not be affected directly by the explosion and fire phase.

Phase 2 (Offshore Spill)

Given the complex life cycles of many species in this region, it is often difficult to maintain a clear distinction between impacts that could occur during Phase 2 of the VLOS scenario and impacts that could occur at Phase 3. The discussion below describes potential effects on fish associated with both of these Phases.

A very large oil spill in the Chukchi Sea could affect marine and anadromous fish and fish habitat through many pathways. Acute and chronic exposures could occur in riverine, estuarine and marine environments which includes habitats in the water column, bottom sediment and sea ice. The exposure pathways for fish include adsorption to outer body, respiration through gills, ingestion, and absorption of dissolved fractions into cells through direct contact.

The severity of the effects on fish would depend on several factors including the type of oil/gas mixture spilled, the thickness of the oil spill, the duration of exposure on the surface, the season of the year (open-water, ice) and the life stage of the fish (egg, larvae, juvenile, adult). Following are the types of effects that could occur to fish from a very large oil/gas spill or blowout:

- Mortality of eggs and immature stages due to acute toxicity of oil and its weathered products
- Mortality of epipelagic eggs and larvae from acute coating with oil layer
- Mortality of adult fish in shallow coastal water bodies with slow water-exchange rates
- Mortality of eggs, immature and adult fish from shock waves from explosive event when pressure, density and temperature rise rapidly in the immediate vicinity
- Immediate loss of some marine, estuarine and riverine habitats from physical oiling
- Contaminant effects on organs, tissues and gills, causing physiological responses including stress and altered respiration, irregular or reduced heart rate, and fluid accumulation; these effects can, in turn, affect swimming, feeding, reproductive and migratory behaviors and the physiologic adjustment for anadromous fish as they move between freshwater and saltwater environments
- Genetic damage to embryos resulting in morphological abnormalities which can affect ability to swim, feed, avoid predators and migrate
- Contaminant exposure in spawning or nursery areas causing abnormal development, or delayed growth through adsorption and ingestion; this abnormal development may repeat through generations if the population continues to spawn and/or rear offspring in contaminated areas
- Displacement of individuals or portions of a population from preferred habitat due to oiling
- Blocked or impeded access to or from spawning, feeding or overwintering freshwater habitats of anadromous fishes due to oiling of estuarine and freshwater environments
- Disruption or re-direction of coastwise migration of migratory and anadromous fish
- Reduction or elimination of prey populations normally available for consumption
- Reduction of individual fitness and survival, thereby increasing susceptibility to predation
- Long-term chronic contaminant effects in fish habitats from weathering oil which produces highly toxic polycyclic aromatic hydrocarbons (PAHs), especially to lipid-rich eggs
- Decreased recruitment into the population due to mortality, abnormal development of eggs and larvae, truncated adult lifespan, reduced adult fitness, increased predation, increased parasitism, and zoonotic diseases
- Intraspecific cascade effects, such as loss of key individuals in social groups, which may show delayed effects on reproduction or feeding behaviors
- Modification of community structure due to increased mortality, reduced recruitment, decreased prey availability, loss of year classes and increased predation
- Modification of ecosystem due to reduction of fish eggs, larvae and adult fish available to predators including seals, sea birds, other fish species and toothed whales, indirectly to polar bears
- Cumulative effects from acute and chronic oil effects overlain on other contemporary stressful events such as water temperature rise, ocean acidity increase and decreasing sea ice

(Nahrgang et al., 2010a,b,c; Boertmann et al., 1998; Jonsson et al., 2010; Pearson et al. 1984; Pinto et al., 1984; Moles and Wade, 2001; Heintz et al., 2000; Patin, 1999; Rye et al., 2000; Christiansen and George, 1995; Christiansen et al., 2010; Mahon et al., 1987; Ott, Peterson, and Rice, 2001; Rice et al., 2000; Carls et al., 2005; Short et al., 2003; Peterson et al., 2003; GESAMP, 1995).

Section IV.E.4 analyzes the potential for reduction of lower trophic species, bioaccumulation, and contamination of these organisms that serve as important prey species to fish in the Chukchi Sea.

Anadromous fish, because they depend on several environments in their complex life history, can be particularly impacted if oil reaches mouths and deltas of anadromous streams and rivers. Oil on the coastline presents a barrier to access (or egress) to spawning, feeding, overwintering and coastwise migration for anadromous species. A VLOS could wash over river deltas, into river mouths and be transported upstream by tidal action or salmon returning to spawn and die in their natal waters. Oil in anadromous water bodies would present contaminants to sensitive spawning areas and life stages. There are many anadromous rivers, streams and lagoons along the Chukchi Sea Coast and Western Beaufort Coast from the Bering Strait to Nuiqsut. The list of anadromous waterbodies in Table 8 are those that have been reported to and documented by the Alaska Department of Fish and Game through the Alaska Anadromous Waters Catalog (ADFG, 2011). Anadromous fish that would be affected by a VLOS in the Chukchi Sea include: Pacific salmon (pink, chum, king, coho, sockeye), least cisco, Bering cisco, Dolly Varden, broad whitefish, humpback whitefish and Arctic char. Figures C-1 to C-5 (in Appendix C) display the anadromous waterbodies used by these species in Northwest Alaska. Although Arctic char are primarily lake dwellers and spawners, it is estimated they spend approximately 10% of the year in nearshore areas feeding in summer before returning to inland waters to spawn (Craig, 1989).

Of the 41 anadromous waterbodies listed in Table 8, 28 of the waterbodies support salmon species. In most cases, the waterbody supports 1 or 2 salmon species, most commonly pink and chum salmon. In a few cases, a waterbody supports 3-5 species of salmon. The Noatak and Kobuk rivers in the southeastern study area support all five species of salmon.

It is estimated that between 0 and 1,368 km of discontinuous shoreline length could be contacted by oil depending on location of a very large oil spill, the season and the number of days after the spill release (see OSRA model results below).

Table 8. Anadromous waters in Northwest Alaska from Bering Strait to Nuiqsut.

River/Stream Name	Species Type
Aukulak Lagoon	Whitefish
Ayugatak Creek	Pink Salmon
Fish Creek	Chum Salmon, King Salmon, Pink Salmon, Dolly Varden, Whitefish
Grouse Creek	Dolly Varden, Pink Salmon
Ikpikpuk River	Pink Salmon
Imikruk Creek	Whitefish
Inmachuk River	Chum Salmon, Pink Salmon
Jade Creek	Dolly Varden
Kiligmak Inlet	Dolly Varden,Whitefish
Killak River	Dolly Varden
Kitluk River	Pink Salmon
Kivalina River	Chum Salmon,Coho Salmon
Kiwalik River	Chum Salmon, Pink Salmon, Dolly Varden
Kobuk River	Chum Salmon, Pink Salmon, Sockeye Salmon, King Salmon, Coho Salmon, Dolly Varden, Whitefish
Kokolik River	Chum Salmon, Pink Salmon, Dolly Varden

River/Stream Name	Species Type
Kougachk Creek	Pink Salmon
Kugrua River	Chum Salmon, Pink Salmon
Kuchiak Creek	Chum Salmon, Coho Salmon
Kuk River	Pink Salmon
Kukpowruk River	Chum Salmon, Dolly Varden
Kukpuk River	Pink Salmon
Kukukpilak Creek	Dolly Varden
Lewis River Channel	Chum Salmon, King Salmon, Pink Salmon, Dolly Vardens, Whitefish
Mint River	Chum Salmon, Pink Salmon, Sockeye Salmon, Dolly Varden
New Heart Creek	Dolly Varden
Noatak River	Chum Salmon, Pink Salmon, Sockeye Salmon, King Salmon, Coho Salmon, Dolly Varden, Whitefish
North Channel Kiwalik River	Chum Salmon, Pink Salmon, Dolly Varden
Nuluk River	Chum Salmon, Pink Salmon, Dolly Varden, Whitefish
Omikviorok River	Dolly Varden, Whitefish
Piasuk River	Whitefish
Pinguk River	Chum Salmon, Pink Salmon, Dolly Varden, Whitefish
Pitmegea River	Chum Salmon, Pink Salmon, Dolly Varden
Rabbit Creek	Chum Salmon, Sockeye Salmon
Smith River	Dolly Varden, Least Cisco, Whitefish
Sulupoaktak Channel	Pink Salmon, Dolly Varden
Trout Creek	Dolly Varden, Whitefish
Ublutuoch River	Chum Salmon, King Salmon, Pink Salmon, Dolly Varden, Whitefish
Upkuarok Creek	Dolly Varden
Utukok River	Chum Salmon, Pink Salmon, Dolly Varden
Wulik River	Pink Salmon
Yankee River	Dolly Varden

Source: Data from Alaska Department of Fish and Game, Anadromous Waters Catalog

Several fish species such as capelin, sand lance, saffron cod, and some sculpin species are not considered anadromous but they use nearshore substrates for spawning and rearing habitats. Nearshore species would be affected through similar pathways as anadromous fish if an oil spill hit the nearshore or shoreline, particularly during critical spawning or rearing times.

Figure IV.C.1 in the Sale 193 FEIS (USDOI, MMS, 2007a) presents a model of the acute and chronic effects of oil on nearshore and intertidal fish, eggs and larvae and the cascade of effects on fish populations. Sand lance would be especially affected in their nearshore habitats because they burrow in sand when they are not out foraging in the water column and they also overwinter in those burrows. Experiments have shown that sand lance are affected negatively by oiled sediments (Pearson et al., 1984; Pinto et al., 1984; Moles and Wade, 2001).

Offshore fish species would experience a variety of effects from a very large oil spill depending on its life history stage (adult, sub adult, egg, larvae); its habitat association (bottom dwelling, mid-water column, upper water column, beneath ice or in ice crevices); the range of depth inhabited; the breadth of the species habitat, prey and range; the life history and behaviors of the species (migratory, sedentary, reproductive strategy, etc); and plasticity of the species to adjust to environmental stressors. Fish found widespread in the Chukchi Sea offshore (and some also nearshore) include Arctic cod, capelin saffron cod, Alaska plaice, yellowfin sole and certain species of sculpin, flounder, poachers, snailfish and eelpouts (Norcross, et al, 2009; Barber et al., 1997; Mecklenberg et al., 2007).

Sedentary, burrowing, territorial, benthic-obligated fish, fish eggs and fish larvae exposed to oil or gas would be limited in their ability to escape or avoid contaminants due to their limited swimming behaviors, obligate life history characteristics, behavioral traits, or spatial limitations. The exposure concentration that these species (including some poachers, eelpouts, sculpin, flounders, snailfish, nesting saffron cod) would experience could be greater than that to which free-swimming fusiform fish would be exposed. Fish that can swim relatively faster and more efficiently (such as salmon, cod, smelt, herring, and sharks) would more likely avoid some of the effects of oil at various concentrations if they have the sensory ability to detect oil or gas components.

Some fish species associate with sea ice to feed, hide and spawn. Most notable of these in the Chukchi Sea is the Arctic cod which associates with ice in various life stages and seasons for shelter and as a forage habitat to feed on microorganisms on the underside of the ice. Under-ice amphipods are an important food source for Arctic cod (Lonne and Gulliksen, 1989; Gradinger and Bluhm, 2004). Rough, irregular textures of the underside-ice may provide preferred habitat for Arctic cod to avoid predators (Cross, 1982). Arctic cod migrate between offshore and onshore areas for seasonal spawning. They spawn under the ice during winter months (Craig, et al, 1982; Craig, 1984; Bradstreet et al., 1986). Eggs hatch under the sea ice after 40-60 days and young larvae remain under the ice, eventually settling towards the bottom in September (Craig 1984; Graham and Hop 1995). For further discussion of the effects of oil on Arctic cod, see Essential Fish Habitat, Section IV.E.6.

Oil and gas released in a winter scenario would pool under the ice in pockets presenting prolonged exposure to Arctic cod eggs and larvae, hiding adults, and amphipods inhabiting the under-ice environment. Pooled under-ice oil could take several pathways between winter and summer months: remain pooled on underside of ice and drifting with ice; remain pooled in open leads; entrain or encapsulate in ice; dissolution into water column; or sinking adhered to sediment (Figures A.1-1, A.1-2). Melt-out of annual sea ice in spring and summer would release oil pooled underneath and trapped in ice and leads. All of these pathways would affect offshore and nearshore Arctic cod and other fish species, including those living in association with ice and those in the water column below ice and ultimately the benthic species affected by sinking oil-laden particulate.

Table C-1 (Appendix C) presents a list of the fish that are known to occur in the Chukchi Sea, the environments they depend upon and a summary of how they could be affected by a very large oil spill, from the time of explosion (Phase 1), to offshore and onshore contact (Phases 2 and 3) and the response, clean-up and long-term recovery (Phases 4 and 5).

Phase 3 (Onshore Contact)

As previously explained, analysis of potential effects on fish during both Phases 2 and 3 of the VLOS scenario are discussed together within Phase 2.

Phase 4 (Spill Response and Cleanup)

Dispersants

Dispersants are a combination of surfactants and solvents that work to break surface oil into smaller droplets which then disperse on the surface and into the water column. Many factors affect the behavior, efficacy, and toxicity of a particular dispersant including water temperature, surface salinity, wave and wind energy, light regime, water depth, type of oil, concentration of dispersant, how the dispersant is applied (constant or intermittent spikes) and exposure time to organisms. Dispersants are used to degrade an oil spill more quickly through increasing surface area and to curtail oil slicks from reaching shorelines (Word et al., 2008).

Application of dispersants can cause toxic effects in fish and particularly fish eggs and larvae. Fish can be affected by dispersed oil through adsorption, ingestion, absorption of dissolved components and respiration (Word et al., 2008). As oil breaks into smaller droplets and sinks in the water column, the droplets are more likely to be ingested by fish that inhabit the water column. Because the surface area of oil increases as it is broken into droplets, there is an increased chance of fish, eggs and larvae in the water column coming into contact with the dispersed oil (Word et al., 2008). If oil droplets adhere to sediment and sink to the seafloor, benthic fish eggs and larvae would then be exposed to oil. In shallow nearshore waters, wind, wave and current action would more likely mix the dispersant-oil mixture into the water column and down to the seafloor which could foul gills and cause changes in histopathology of the gills (Khan and Payne, 2005).

The effect of dispersant application in a very large oil spill in the Chukchi Sea would be similar to the toxicity and fouling effects outlined above under Phases 2 and 3 of the oil spill itself (Offshore Spill and Onshore Contact). Epipelagic fish eggs and larvae would be particularly sensitive to effects of dispersant application. Fish in the water column and the benthos would be variably affected as a function of the species, life stage, depth inhabited, time of reproductive cycle, feeding strategy and ability to adapt by sensing the chemical changes and moving out of the range of toxic effects.

In-Situ Burning

In-situ burning is used to remove oil from the surface and to curtail oil slicks from reaching shorelines. In-situ burning could affect fish through elevation of surface-water temperature; boom dragging for oil collection; and sinking of residues. These effects on fish would differ depending on the time of year (open-water vs. ice-cover) and the size and duration of the burn.

The upper-most layer of water (upper millimeter or less) that interfaces with the air is referred to as the microlayer. Important chemical, physical and biological processes take place in this layer and it serves as habitat for many sensitive life stages including fish eggs, fish larvae, and microorganisms important as prey for fish (GESAMP, 1995). Disturbance to this layer through boom-dragging to collect oil and temperature elevation from burning could cause lethal effects on fish life stages in this layer. In open water, the effects would be limited to the surface area burned and to the duration of a burn in any one area. Free-swimming adult fish not obligated to a specific habitat would likely move out of the area.

If an oil spill occurred in winter, in-situ burning would be limited by the lack of open water to collect oil and the area of open water in which to maneuver vessels and contain oil to an optimal thickness to burn (greater than 1-2 mm). If it could occur on a limited scale, sea ice would melt in the immediate vicinity of the burn and fish associated with the ice would be negatively affected by the operation. Residues from in-situ burning can float or sink depending on the temperature and age of the residue. Floating residue can be collected; however, residues that sink could foul gills and expose benthic organisms to oil components as the residue degrades on the seafloor.

The NOAA Office of Response and Restoration states that, “Overall, these impacts [from open water in-situ burning] would be expected to be much less severe than those resulting from exposure to a large, uncontained oil spill” (http://response.restoration.noaa.gov, In-Situ Burning).

Offshore Vessels and Skimmers

During the spill response and cleanup phase, fish could be exposed to a variety of effects from offshore vessel traffic including:

- noise from engines, equipment and propellers;
- seismic surveys used to locate debris and drill relief well;
- potential for introduction of invasive species from foreign or out-of-state vessels;
- regulated and unregulated discharges into the ocean;
- potential for vessel groundings and accidental spills;
- anchoring in benthic habitat; breaking of ice habitat from ice-breaker operations; and

- surface skimming or vacuuming of oil from microlayer by collection skimmers.

Noise from ships, sound from seismic surveys and other sound sources would affect fish through interference with sensory orientation and navigation, decreased feeding efficiency, scattering of fish away from a food source, redistribution of fish schools and shoals, and producing a generalized stress response in some fish species which can weaken fish immune systems (Fay, 2009; Jobling, 1995; Radford et al., 2010; Simpson, Meekan, Larsen et al., 2010; Slabbekoorn et al., 2010; Purser and Radford, 2011; Wysocki, Dittami, and Ladich, 2006). Pelagic species, such as adult Arctic cod, adult salmon and similar species would startle and scatter as noise continues and, in theory, receive reduced levels of sound. Sedentary, burrowing, territorial, benthic-obligated fish, shallower near-shore fish, fish eggs and fish larvae in the area of the rig and oil spill would be exposed to higher noise levels due to their limited swimming behaviors, obligate life history characteristics, behavioral traits or spatial limitations. Foraging and reproduction behaviors of these benthic-obligate fish could be affected negatively by seismic activities and noise.

There is a low probability risk of introducing invasive species brought in from other seas through vessel hulls and equipment deployed overboard. Invasive species, including microorganisms, could affect fish due to disease, competition for food or competition for habitat.

Skimming or vacuuming the microlayer would disturb chemical, physical and biological processes that take place in this layer and would injure or kill sensitive pelagic life stages including fish eggs, fish larvae and microorganisms that are important prey for fish (GESAMP, 1995). Ice-breakers would cause disturbance to ice habitat, and depending on the time of year, could affect the eggs and young larvae or Arctic cod.

Drilling of Relief Well

Drilling an emergency relief well would entail vessel noise, seismic surveys, drilling noise and vibration, discharge of drilling muds and cuttings, wastewater discharges as permitted by regulation, potential for accidental spills, and potential for introduction of invasive species from vessel or equipment placed overboard. These actions could cause startle and disorientation behavior in fish, exposure to contaminants, physical disturbance to seafloor habitat, increased suspended sediment and reduced visibility in the water column.

Benthic-obligate fish could be affected more than pelagic free-swimming fish by relief well drilling because of their relative inability to escape noise, disturbance, or contaminants, and due to disturbance of benthic habitat around the drill site. The effects of well-drilling on water quality and fish were discussed in detail in the Sale 193 FEIS (USDOI, MMS, 2007a).

Beach Cleaning

The cleaning up of oiled beaches (and rescue of oiled animals) could entail small boat and aircraft landings on marine and freshwater shorelines; large numbers of people walking and wading through aquatic habitats; collection of oiled sediment and beach wrack; possible hydraulic washing with hot water; possible application of fertilizer to enhance degradation of oil; and possible raking of fine sediments.

These beach cleaning activities could result in effects on fish including: trampling of intertidal and nearshore, riverine and riparian habitats; crushing of eggs and benthic larvae; aberrant behaviors due to noise; suspended sediment in waters and resettlement of sediments elsewhere; runoff of treatment-laden waters that could affect nearshore temperature and nutrient concentrations; removal of beach wrack nutrient sources; removal of intertidal hiding habitat; and potential for introduction of invasive species from small boats, aircraft pontoons, and waders worn by workers from outside of the Alaska Arctic region.

Phase 5 (Long Term Recovery)

In long-term recovery, there would be a continued presence of people in the area for monitoring and research which would include small boat and aircraft landings on shorelines and people walking and wading through aquatic habitats. These activities could result in trampling of fish habitats, noise and disturbance to fish and removal of fish from the system for research purposes.

Over the long-term, contamination of aquatic environments from oil (and possibly dispersant residue on the seafloor) would continue from oil breakdown products such as polyaromatic aromatic hydrocarbons (PAHs). Sunlight (UV radiation) increases the toxicity of PAHs so summer sunlight in Arctic Alaska may exacerbate the amount and degree of toxicity exposure.

Long-term chronic effects from oil would occur in fish that occupy estuarine, intertidal and freshwater habitats where oil accumulates and weathers, producing PAHs especially toxic to lipid-rich eggs (as would be the case with pink salmon and capelin). If chronic exposures persist, stress may manifest sublethal effects later in the form of histological, physiological, and behavioral responses, including impairment of feeding, growth, and reproduction (Heintz et al., 2000). Chronic toxicity and stress may also reduce fecundity and survival through increased susceptibility to predation, parasite infestation, and zoonotic diseases. The frequency of a single symptom does not necessarily reflect the effects of oil on the organism, so the cumulative effects of all symptoms of toxicity must be considered in evaluating acute and chronic effects of oil on fish.

Contaminant exposure can make a spawning site unavailable for multiple generations if the oil is detectable by the fish. If a population continues to spawn and/or rear offspring in oil-contaminated areas, abnormal development, genetic alterations or abnormal behavior may repeat through successive generations. The likely results would be fewer juvenile fish survive, so that recruitment from the early life stages is reduced and adult populations decline. Declining adult populations may not be replaced at sustainable levels. Ultimately, these cumulative effects on individuals can affect the population abundance and, subsequently, community structure (Patin, 1999; Ott, Peterson, and Rice, 2001; Rice et al., 2000). Moles and Norcross (1998) documented deleterious effects on juvenile flatfish species, including yellowfin sole, that were exposed to sediments laden with Alaska North Slope crude oil. The effects of this controlled laboratory experiment included changes in tissues and significant decreased growth rates in yellowfin sole juveniles at 30, 60 and 90 days of exposure.

Table C-1 (in Appendix C) presents a list of the fish that are known to occur in the Chukchi Sea, the environments they depend upon and a summary of how they could be affected by a very large oil spill, from the time of explosion (Phase 1), to offshore and onshore contact (Phases 2 and 3) and the response, clean-up and long-term recovery (Phases 4 and 5).

Oil Spill Trajectory Analysis

The following paragraphs present results estimated by the OSRA model from a very large oil spill contacting coastal land segments and resource areas that are important to fish and their habitats. The trajectory estimates are based on the assumption that a spill has occurred (Appendix B). 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. The effects of subsurface transport of oil in water, tarballs washed onto beaches, and persistence of oil once it has reached coastlines is evaluated through relevant scientific literature.

Summer 60 Days

Alaska Coastline. The OSRA model estimates that <0.5 – 11 % of the trajectories from LA1–LA13 would contact some portion of the Alaska coastline (LSs 64–89)(Appendix B, Table B-9, Figure B-7). Table 8 lists the coastal streams and rivers important to anadromous fish. Tables 9 and 10 (below) list the coastal water bodies in each land segment. Some of the most biologically important water bodies along the U.S. Chukchi Sea coastline include Leynard Bay, Kasegaluk Lagoon, Ledyard Bay, Peard Bay, Pitimega River, Kugra River, Noatak River, Kobuk River and Kukpowruk River. Overall, it is estimated that 0-1,046 km of discontinuous shoreline could be contacted from LAs 1-13.

The OSRA model estimates that <0.5-11% of the trajectories from a very large oil spill starting at LA1-LA13 contacts land segments (LS) containing streams important to spawning chum salmon including (among others) Pitmegea River (LS 67), Kukpowruk River (LS 71), Kugrua River (LS 80) (Appendix B, Table B-9 and Appendix C, Figure C-1).

The OSRA model estimates that a <0.5-11% of the trajectories from LA1-LA13 contacts land segments that have streams important to spawning pink salmon in the Kuk, Kokolik, Utukok, Ikpikpuk and Kukpowruk (among other) rivers along the Chukchi Sea coast.

The greatest percentage of trajectories that contact LSs that contain chum and pink salmon streams occurs from Launch Areas 12 and 13 (<0.5-11%); these two land segments are in closer proximity to the coastline than the other Launch Areas. The OSRA model estimates that trajectories from LA 10 would contact the greatest number of land segments (9 total); trajectories from LA 11 would contact the next greatest number (8) of land segments.

While the entrances to salmon-spawning streams are relatively easy to identify, other resource areas important to fish also exist along the Chukchi Sea coastline. For example, the Kasegaluk Lagoon complex (LSs 73-75) includes an estuary important to rearing fish, including outmigrating salmon smolts from the Kukpowruk, Kokolik, and Utukok rivers. Also, adult salmon appear to make use of the area as evidenced by the capture of 17 adults there (Craig and Halderson, 1986, citing Craig and Schmidt, 1985). Salmon and other fish appear to be the attractant for very large numbers of migratory birds that make use of the area during May-October (Kinney, 1985). The OSRA estimates that <0.5–4% of the trajectories from LA11 would contact Kasegaluk Lagoon (Appendix B, Table B-7; Figure B-7).

The Bering Sea lies south of Bering Strait. Many pelagic Bering Sea fish species inhabit the Bering Strait. The OSRA model estimates that 1% of the trajectories would contact the western Bering Strait waters (BS2) from LA9 (Appendix B, Table B-13; Figure B-1). The OSRA model estimates that < 0.5-4% of trajectories from LA1-LA13 would contact northeast Chukchi Sea Boundary Segments 17-22, which is habitat for epipelagic fish including Arctic cod sensitive life stages. (Appendix B, Table B-13 and Figure B-1).

Approximately 30% of a 60,000 bbl crude oil spill during summer would remain (in water column, in bottom sediments, ingested, beached) after 30 days. It is estimated that 33% of the oil spill would disperse and 37% would evaporate after 30 days in a summer spill (Appendix B, Table B-4). Through 60 days after a very large oil spill in summer, the OSRA model estimates that between 245,800 and 364,200 km2 of discontinuous ocean surface would be contacted by trajectories from LA1–LA13. The greatest discontinuous ocean surface area contacted would be generated by LA8; the least by LA9 (Appendix B, Table B-5). Ocean surface is an important habitat for epipelagic fish, eggs and larvae which include life stages of Arctic cod.

The OSRA trajectory model estimates movement of a surface oil slick, however, it does not assess subsurface transport of oil in water, tarballs washed onto beaches or persistence of oil once it has reached spawning beaches, rearing areas or spawning streams. The Sale 193 FEIS, Appendix A, Section B.3 discusses shoreline type and oil persistence.

Table 9. Range of fractions of a Very Large Oil Spill (expressed as percentages) starting from a given location that will contact Alaska coastal land segments (LS) within 60 or 360 days.

Season / Analysis Period	% Range of Contact to LSs	LSs Contacted from LA1–LA13	LSs with Anadromous Waters Contacted from LA1–LA13 >0.5%
Summer 60 days	<0.5–11% from Launch Areas 3-13	#64–89 from Launch Areas 3–13	#64, 66-68, 70–74,78–80
Summer 360 days	<0.5–13% from Launch Areas 2-13	#64– 89, 91 from Launch Areas 3-13	#64, 66-68, 70–74,78–80
Winter 360 days	<0.5–7% from Launch Areas 1-13	#64-65, 70–76, 78–79, 80–88 from Launch Areas 1-13	#64,70–74, 78–80
Geographic Name of Land Segments: 64- Aiautak Lagoon, Ipiutak Lagoon, Kowtuk Point, Kukpuk River, Pingu Bluff, Point Hope, Sinigrok Point, Sinuk; 65- Buckland, Cape Dyer, Cape Lewis, Cape Lisburne;66- Ayugatak Lagoon: 67- Cape Sabine, Pitmegea River; 68- Agiak Lagoon, Punuk Lagoon; 69- Cape Beaufort, Omalik Lagoon; 70- Kuchaurak Creek, Kuchiak Creek; 71- Kukpowruk River, Naokok, Naokok Pass, Sitkok Point; 72- Epizetka River, Kokolik River, Point Lay, Siksrikpak Point; 73- Akunik Pass, Tungaich Point, Tungak Creek; 74- Kasegaluk Lagoon, , Solivik Island, Utukok River; 75- Akeonik, Icy Cape, Icy Cape Pass; 76- Akoliakatat Pass, Avak Inlet, Tunalik River; 77- Mitliktavik, Nivat Point, Nokotlek Point, Ongorakvik River; 78- Kilmantavi, Kuk River, Point Collie, Sigeakruk Point; 79- Point Belcher, Wainwright, Wainwright Inlet; 80- Eluksingiak Point, Igklo River, Kugrua Bay; 81- Peard Bay, Point Franklin, Seahorse Islands, Tachinisok Inlet: 82- Skull Cliff:83- Nulavik, Loran Radio Station:84- Walakpa River, Will Rogers and Wiley Post Memorial; 85- Barrow, Browerville, Elson Lagoon; 86- Dease Inlet, Plover Islands, Sanigaruak Island; 87- Igalik Island, Kulgurak Island, Kurgorak Bay, Tangent Point; 88- Cape Simpson, Piasuk River, Sinclair River, Tulimanik Island; 89- Ikpikpuk River, Point Poleakoon, Smith Bay; 91- Lonely AFS Airport, Pitt Point, Pogik Bay, Smith River			

Russia Far East Coastline. The Russia Far East coast has many coastal rivers, lagoons and bays (Appendix C, Figure C-9), with habitat that supports fish including: Uelen Lagoon and River(LS39); Inchoun Lagoon and River (LS 38); Chetigun River (LS 37); Koluychin Bay and Koluychin Islands (LS 30-31); and Vankarem Lagoon and River (LS 29-30). King, sockeye, coho, chum and pink salmon have been documented in coastal waters from Uelen Lagoon to Koluychin Bay. The Chetigun River is noted for supporting spawning and juvenile populations of king, sockeye, pink and chum salmon.

The OSRA model estimates that <0.5- 2% of the trajectories from LAs 1-13 would contact the Russian Far East coastline (Land Segments 27, 32-39) within 60 days, during summer. Launch Area 9 has the highest percentage of trajectories that would reach the coast. All the Russia Far East land segments with percentage of trajectories contacting (LSs 27, 32-39) contain coastal rivers. (Appendix B, Table B-9)

Table 10. Range of fractions of a Very Large Oil Spill (expressed as percentages) starting from a given location that will contact Russia coastal land segments (LSs) with 60 or 360 days.

Season / Analysis Period	% Range of Contact to LSs	LSs with Anadromous Waters Contacted from LA1–LA13 >0.5%
Summer 60 days	<0.5 - 2% from Launch Areas 4 and 9	27, 32-39
Summer 360 days	<0.5 - 10% from Launch Areas 4,8,9, 10	8, 26-39
Winter 360 days	<0.5 - 5% from Launch Areas 1,2,4,9,11	7,8, 25-39
Geographic Name of Land Segments Contacted in Far East Russia: 7- Kosa Bruch; 8- Klark, Mys Litke, Mys Pillar, Skeletov, Mys Uering; 25- Laguna Amguema, Ostrov Leny, Yulinu; 26- Ekugvaam, Reka Ekugvam, Kepin, Pil'khin; 27- Laguna Nut, Rigol; 28- Kamynga, Ostrov Kardkarpko, Kovlyuneskin, Mys Vankarem, Vankarema, Laguna Vankarema; 29- Akanatkhyrgyn, Nel'teyveyam, Mys Onman, Vel'may; 30- Laguna Kunergin, Nutepynmyn, Pyngopil'khin, Laguna Pyngopil'khin; 31-Alyatki, Zaliv Tasytkhin, Kolyuchin Bay; 32- Mys Dzhenretlen, Eynenekvyk, Lit'khekay-Polar Station; 33- Neskan, Laguna Neskan, Mys Neskan; 34- Emelin, Ostrov I dlidlya, I, Memino,Tepken; 35- Enurmino, Mys Keylu, Netakeniskhvin, Mys Neten; 36- Mys Chechan, Mys Ikigur, Keniskhvik, Mys Serditse Kamen; 37-Chevgtun, Utkan, Mys Volnistyy; 38- Enmytagyn, Inchoun, Inchoun, Laguna Inchoun, Mitkulino, Uellen, Mys Unikin; 39- Cape Dezhnev, Mys Inchoun, Naukan, Mys Peek, Uelen, Laguna Uelen, Mys Uelen		

Summer within 360 Days

Alaska Coastline. The OSRA model estimates that <0.5- 13% of the trajectories from LAs 1-13 would contact some portion of the Alaska coastline (LSs 64- 89, 91) (Appendix B, Table B-10, Figure B-7).

The greatest percentage of trajectories that contact chum and pink salmon streams (<0.5-13%) occurs from LAs 12 and 13, which are in closer proximity to the coastline than the other LAs. Trajectories from LAs 10 and 11 would contact the greatest number (9, 8 respectively) of land segments with anadromous waters. It is estimated that 0–1,368 km of discontinuous shoreline could be contacted from LAs 1-13 (Table 5 in Section IV.D.2).

The OSRA model estimates that a percent of trajectories from a very large oil spill starting at LA1-LA13 would contact land segments containing important salmon spawning streams including the Kukpowruk River (LS 71; <0.5-2%), Kuk River (LS 64, <0.5-3%) and Kugrua River (LS 80, <0.5-5%).

The greatest percentage of trajectories that contact the coastline occurs at part of Kasegaluk Lagoon (LS 73-75), where <0.5-4% of the trajectories from LAs10 and 11 contact (Appendix B. Table B-17). The percentage of trajectories that contact Kasegaluk Lagoon is highest because the OSRA model's launch area and the land segments are in close proximity to each other (Figures B-3, B-10). The LAs 10 and 11 contact the greatest number of land segments with anadromous waters (Appendix C, Figures C-1, C-2, C-3, and C-5).

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) (USDOI, MMS, 2007a, Appendix A-Table A.1-8). The OSRA model estimates that <0.5-31% of the trajectories from LA1-LA13 would contact the United States Chukchi Coast (Grouped Land Segments 96) within 360 days during summer. LA10–LA13 has the highest percentage of trajectories that would contact this area (Appendix B, Table B-12).

As the Chukchi Sea Sale 193 area is adjacent to the Beaufort Sea, the potential was estimated for a VLOS originating in the Chukchi Sea to contact the Beaufort Sea coast. The model estimates that between <0.5-20% of trajectories from LAs 1-13 contact the United States Beaufort Coast (GLS 97). Launch Areas 8 and 18, the most northeast launch areas, have the greatest percentage of trajectories that contact the Beaufort Sea land segments (Appendix B, Table B-12). This region is an important area for nearshore and anadromous fish migration and spawning.

The Bering Sea lies south of Bering Strait. Many pelagic Bering Sea fish species inhabit the Bering Strait. The OSRA model estimates that <0.5-1% of the trajectories from LA9 would contact the western Bering Strait waters (BS 2). All other LAs are <0.5%. The OSRA model estimates that <0.5-12% of trajectories from LA1-LA13 would contact northeast Chukchi Sea BSs 17-22, which is habitat for epipelagic fish including sensitive life stages of Arctic cod (Appendix B, Table B-13; Figure B-1).

Approximately 30% of oil spill during summer would remain (in the water column, in bottom sediments, ingested, beached) after 30 days. It is estimated that 33% of the oil spill would disperse and 37% would evaporate after 30 days in a summer spill (Appendix B, Table B-4). Through 360 days after a very large oil spill in summer has frozen into the sea ice, it is estimated that between 264,500 and 547,600 km2 of discontinuous ocean surface would be contacted by oil trajectories from LA1-LA13. The greatest discontinuous ocean surface area contacted would be generated by LA8; the least by LA9 (Appendix B, Table B-5). Ocean surface is an important habitat for epipelagic fish, eggs and larvae, including Arctic cod.

The OSRA trajectory model predicts movement of a surface slick, however, it does not assess subsurface transport of oil in water, tarballs washed onto beaches or the persistence of oil once it has reached spawning beaches, rearing areas, or spawning streams. The Sale 193 FEIS, Appendix A, Section B.3 discusses shoreline type and oil persistence.

Russia Far East Coastline. The OSRA model estimates that <0.5-10% of the trajectories from LAs 4,8,9, 10 would contact the Russia Far East coastline (Land Segments 8, 26-39), including Wrangel Island. The LA8 has the highest percentage of trajectories that would reach the mainland coast. The model estimates that <0.5% of the trajectories from all other LAs would contact the Russia Far East Coast or Wrangel Island. All the Russia Far East and Wrangel Island land segments with percentage of trajectories contacting (Land Segments 8, 26-39) have coastal rivers (Appendix C, Figure C-9).

Winter 360 Days

Alaska Coastline. The OSRA model estimates that <0.5-7 % of the trajectories from LA1-LA13 would contact some portion of the Alaska coastline (Land Segments 64-65, 70-76, 78-79, 80-88) (Table B-10).

The OSRA model estimates that a percent of trajectories from a very large oil spill starting at LA1-LA13 would contact land segments containing important salmon spawning streams including the Kukpowruk River (LS 71; <0.5-3%), Kuk River (LS 64, <0.5-1%), Kugrua River (LS 80, <0.5-4%) and Kasegluk Lagoon (LS 73-74, <0.5-5%).

The greatest percentage of trajectories that contacts the coastline occurs at part of Kasegaluk Lagoon (LS 73), where 5% of the trajectories from LA10 contact (Appendix B. Table B-17). The percentage of trajectories that contact Kasegaluk Lagoon is highest because the OSRA model’s launch area and the land segments are in close proximity to each other (Figures B-3, B-10). The LAs 10 and 11 contact the greatest number of land segments with anadromous waters (8 and 7 respectively) (Appendix C, Figures C-1, C-2, C-3, and C-5). It is estimated the 0–1,287 km of discontinuous shoreline could be contacted from LAs 1–13 (Section IV.D.2, Table 5).

There are many locations where oil may contaminate substrates in estuarine, intertidal and freshwater habitats that are used for spawning and rearing fish populations such as pink salmon or capelin. The OSRA trajectory model estimates the trajectories of a surface oil spill; however, it does not assess subsurface transport of oil or the fate or persistence of oil once it has reached spawning beaches, rearing areas or spawning streams. The Sale 193 FEIS, Appendix A, Section B.3 discusses shoreline type and oil persistence. PAHs in weathered oil can persist in these spawning and rearing habitats for long periods and remain as a source of toxicity to sensitive life stages.

The OSRA model estimates that <0.5-10% of trajectories from LA1–LA13 would contact the United States Beaufort Sea Coast (GLS 97) (Appendix B, Table B-20). An oil spill that occurs in winter during broken-ice in fall or under-ice would melt out of the ice the following summer. It is estimated that approximately 48% of oil spilled during winter would remain (in the water column, in bottom sediments, ingested by organisms or beached) after 30 days after meltout. It is estimated that 15% of the winter oil spill would disperse and 37% would evaporate in 30 days after meltout (Appendix B, B-4). Through 360 days after a very large oil spill in winter, it is estimated that between 368,400 and 507,200 km^2 of discontinuous ocean surface would be contacted by oil trajectories from LA1-LA13. The greatest discontinuous ocean surface area contacted would be generated by LA4; the least by LA3 (Appendix B, Table B-6). Ocean surface and sea ice are important habitats for epipelagic fish, eggs and larvae, including sensitive life stages of Arctic cod.

Russia Far East Coastline. The OSRA model estimates that <0.5-5% of the trajectories from LAs 1,2,4,9,11 would contact the Russia Far East and Wrangel Island coastline (Land Segments 7,8, 25-39). The LA9 has the highest percent trajectories that would reach the Russia Far East mainland coast. All the Russia Far East and Wrangel Island land segments that have some percentage of trajectories contacting (LSs 7,8, 25-39) have coastal rivers (Table B-10 and Figure C-9).

Conclusion

The level of effects of a very large oil spill in the Chukchi Sea on a fish species and its population would depend on many factors including:

- life stage affected (egg, larvae, juvenile, adult)
- species distribution and abundance (widespread, rare)
- habitat dependence (ocean water column, sea surface, benthos, sea ice, estuarine, freshwater),
- life history (anadromous, migratory, reproductive behaviors and cycle, longevity,etc)
- extent and location of spawning areas in the estuarine or riverine systems
- species exposure and sensitivity to oil and gas (toxicology, swimming ability)
- effect on prey species
- location of the oil spill (nearshore, further offshore), depth at which the hydrocarbon release occurs (seafloor, mid-column or surface), ratio of the mixture of oil and gas released, and time of year oil spill occurs

Considering all these factors, some species or life stages of a species could be significantly affected (defined here as greater than 3 generations to return) at a population level.

The species that would be particularly vulnerable to effects at individual and population levels include: pink and chum (eggs, larvae, juveniles); Arctic cod (eggs, larvae, juveniles, adults); sand lance (adults, eggs, larvae); capelin (adults, eggs, larvae); nearshore sculpin species (eggs, larvae, adult); nearshore flounders and plaice (eggs, larvae, adults); saffron cod (adults, eggs, juveniles); migratory least cisco (adults, juveniles); migratory Dolly Varden; migratory Arctic char; rainbow smelt; stickleback; and migratory whitefish. Other fish species that could be affected by a VLOS include: offshore sculpin, eelpouts, poachers; snailfish, alligatorfish, eelblennies, lamprey, herring, coho, sockeye and king salmon (Appendix C, Table C-1).

The selection of Alternative III or Alternative IV (coastwise corridor deferrals), which includes parts of LAs 8-13, would reduce the chance of a very large oil spill from contacting important nearshore, estuarine, intertidal and riverine habitats. Direct effects of an oil spill would be reduced on anadromous, migratory, nearshore and estuarine fish, fish eggs, fish larvae and their populations. The larger deferral associated with Alternative III has greater potential to reduce nearshore impacts as compared with Alternative IV.

IV.E.6. Essential Fish Habitat

The Sale 193 FEIS and the Arctic Multi-Sale Draft EIS detail the effects of a large oil spill on EFH (USDOI, MMS, 2007a, 2008a) and are incorporated here by reference.

Arctic Fishery Management Plan

Two Fishery Management Plans apply to the area under consideration in this VLOS analysis: the Fishery Management Plan for Fish Resources of the Arctic Management Area (Arctic FMP) (NPFMC, 2009); and the Salmon Fishery Management Plan for Coastal Alaska (Salmon FMP) (NPFMC, 1990). The Arctic FMP was approved by the Secretary of Commerce in 2009. The Plan closed the U.S. Arctic area to commercial fishing. The Arctic FMP does not regulate subsistence or personal-use harvests of any fish, shellfish, birds, or marine mammals.

Based on the best scientific information available at the time of publication in 2009, the Arctic FMP identified three species as potential commercial target species and defines Essential Fish Habitat (EFH) for certain life stages of those species (Table 11).

Table 11. Target species and life stage for which EFH has been described in the Arctic Fishery Management Plan for the Chukchi Sea.

Arctic Fishery Management Plan: EFH Species	Eggs EFH	Larvae EFH	Late Juvenile EFH	Adults EFH
Arctic cod (Boreogadus saida),			X	X
saffron cod (Eleginus gracilis)			X	X
opilio crab (Chionoecetes opilio)	X		X	X

Note: NMFS has not yet determined EFH for eggs and larvae of some species

Text descriptions of the three target species identified in the Arctic Fishery Management Plan (Arctic cod, saffron cod, and opilio crab – adult and late juvenile for each species), as well as discussion of eight ecosystem component species, is provided in Section III.B.3. The EFH designations are shown in Appendix C, Figures C-6, C-7, and C-8.

Arctic Cod

Arctic cod is widely distributed in the U.S. Arctic in the pelagic, demersal and nearshore environments. The distribution and density of Arctic cod in the Chukchi and Beaufort Seas depends on the time of year and the stage of their life history. Norcross et al. (2009) collected Arctic cod adults in bean trawls in the Chukchi Sea in summer 2004 at depths from 33 to 96 m. They also collected Arctic cod eggs, larvae and juveniles in plankton tows between 22 and 81 m; Arctic cod icthyoplankton was numerically the most dominant species. The absolute numbers of Arctic cod and their biomass is one of the highest of any finfish in the region (Logerwell et al., 2010; Frost and Lowry, 1983). Results of a 2008 NOAA survey showed that Arctic cod were the most abundant fin-fish caught in a summer survey in the Central Beaufort Sea, both by weight and absolute numbers. Pelagic yearling and older Arctic cod were most abundant at the continental shelf-break (100 m, 328 ft); pelagic young-of-year were most commonly found inshore (Logerwell et al., 2010). Frost and Lowry (1983) found smaller Arctic cod more often in water less than 100 m deep. Craig et al. (1982) found adult and juvenile Arctic cod in shallow nearshore waters (1-12 m) in the Beaufort Sea in winter and summer. Arctic cod were identified in high densities using acoustic measurements in the bottom of Barrow Canyon at depths of 200-250 m and along the steep canyon walls between 125 and 200 m during a research cruise from early September to early October 2002 (Crawford, 2003).

Arctic cod are associated with sea ice, using it at various life stages and seasons for shelter and as a forage habitat to feed on microorganisms on the underside of the ice. Amphipods are an important food source for Arctic cod on the underside of ice (Lonne and Gulliksen, 1989; Gradinger and Bluhm, 2004). Rough, irregular textures of the underside-ice may provide preferred habitat for Arctic cod to avoid predators (Cross, 1982). Gradinger and Bluhm (2004) and Lonne and Gulliksen (1989) observed and photographed Arctic cod in summer months using ice crevices and cracks on the underside of textured ice floes for escape and shelter.

Arctic cod also inhabit offshore and nearshore areas without ice during warmer times of year (Bradstreet and Cross, 1982; Bradstreet, 1982; Cross, 1982; Crawford and Jorgenson, 1993; Gradinger and Bluhm, 2004). Copepods and amphipods are common prey for Arctic cod in open water (Lowry and Frost, 1981; Benoit et al. 2010).

Arctic cod move and feed in different groupings – as dispersed individuals, in schools, and in huge shoals. These distribution patterns appear to be dependent on several interacting factors including season, presence or absence of ice, salinity, water temperature, surface wind, currents, and underside texture of ice. Inter-annual variation also plays a role in the pattern of distributions. Welch et al., (1993) documented huge, dense schools of Arctic cod pooling in deep basins in bays and inlets during open water in the Canadian Beaufort. Benoit et al. (2010) found diel vertical migration of Arctic cod in the Eastern Canadian Beaufort was dependent on daylight length and presence of prey; by May, in prolonged daylight, vertical migration stopped and Arctic cod increased their schooling and feeding activity.

Arctic cod migrate between offshore and onshore areas for seasonal spawning. They spawn under the ice during winter (Craig, et al, 1982; Craig, 1984; Bradstreet et al., 1986). Arctic cod eggs and larvae are pelagic. Studies suggest that the egg incubation period is between 45-90 days (Sameto, 1984).

Ringed seals, ribbon seals, spotted seals, beluga whales and several seabird species depend heavily on Arctic cod (Bradstreet, 1982; Bradstreet and Cross, 1982). Ice seals particularly depend upon Arctic cod in the winter (Bluhm and Gradinger, 2008; Dehn et al., 2007; Frost and Lowry, 1984; Welch et al, 1993). The biomass of Arctic cod (as both predator and prey) transfers energy throughout the food web (Crawford and Jorgenson, 1996; Bradstreet et al., 1986). The abundance, wide distribution and the role in the food web of Arctic cod in the Beaufort Sea make this species very important in the ecosystem of the U.S. Arctic region.

Saffron Cod

Saffron cod occurs in the Chukchi Sea primarily in nearshore waters. Unlike Arctic cod, they do not specifically associate with ice. Saffron cod move seasonally from summertime feeding offshore to inshore for spawning. They enter coastal waters and tide-influenced riverine environments. Adults and juveniles forage on the epibenthos, opportunistically taking small crustaceans and fish (Froese and Pauly, 2010). Saffron cod are important in the diet of several seabirds (Piatt et al., 1989), ringed seals, spotted seals and beluga whales (Frost and Lowry, 1984; Lowry et al., 1980).

Saffron cod have been captured in several surveys in the Chukchi Sea. Saffron cod was one of the ten most dominant fish captured by Alverson and Wilimovsky (1966) in their field investigation of the Chukchi Sea in 1959. Barber et al. (1997) caught a high abundance of saffron cod in a demersal fish survey during August and September in 1990 and 1991 at sampling sites in the Chukchi Sea from Point Hope north. In 2004, saffron cod were collected in the Chukchi Sea in depths from 34-51 m as part of the Russian-American Long-term Census of the Arctic (RUSALCA) (Mecklenburg et al., 2007, Norcross et al., 2010). These studies indicate that saffron cod are inflcuenced by water temperature, salinity and substrate type and are commonly found nearhore in warmer coastal waters.

Pacific Salmon

Pacific salmon (*Oncorhynchus* sp.) occur in the Beaufort Sea (Craig and Haldorson, 1986; Babaluk et al., 2000). Pink and chum salmon are the most common of the five species. In 1986, Craig and Haldorson summarized the distribution of Pacific salmon in Arctic Alaska:

> All five North American Pacific salmon species occur in small numbers in arctic waters, but only pink and chum salmon appear to have viable populations north of Point Hope, Alaska. Pink salmon are the most common species and constitute 85% of salmon caught in biological surveys. Pink salmon apparently have small runs in eight arctic drainages, while chum salmon may have small runs in six. Arctic pink salmon are smaller in size than individuals to the south but have similar meristic characteristics. It is likely that minimal use of freshwater habitats by pink and chum salmon has allowed them to colonize characteristically cold arctic rivers.

Seventeen waterbodies (rivers, streams, lagoons) between Point Hope and the Alaska-Canada border were identified by Craig and Haldorson (1986) that apparently support small populations of pink and chum salmon. A few isolated spawning stocks of chum and pink salmon occur in the Beaufort Sea area, primarily the Sagavanirktok and Colville rivers. Records of individual king, coho and sockeye salmon were also identified in these waterbodies, which Craig and Haldorson attributed as probable strays. Alaska Department of Fish and Game maintains the Anadromous Waters Catalog of Alaska for the waterbodies and species documented to date (ADFG, 2011). In 2000, Babaluk et al. reported capture records of sockeye, pink, chum, and coho salmon in the western Canadian Arctic. Eight of the sockeye salmon caught in a Banks Island subsistence fishery were sexually mature. These records documented significant extensions of the previously known ranges for Pacific salmon in the Canadian Arctic.

Substantial populations of salmon may have a difficult time establishing and persisting in the Arctic, most likely because of the limitation of freshwater spawning habitats which freeze over in winter and are not suitable for overwintering eggs and young (Craig, 1989; Fechhelm and Griffiths, 2001).

In the marine environment, adult pink and chum salmon in Alaska seas can be found down to 200m (660 ft) depth. Moss et al. (2009) trawled high densities of juvenile pink and chum salmon at or near the surface offshore in the Chukchi Sea in September, 2007.

The quality of Essential Fish Habitat in the U.S. Arctic can be affected by coastal construction and runoff, vessel discharges, underwater noise, and ongoing oil and gas industry activities including petroleum spills. Climate change in the Arctic is a past and ongoing factor that affects the quality of EFH in several ways including: changes in seawater temperature and acidity; changes in extent and quality of sea ice habitat; and changes in freshwater discharge and nearshore salinities (Hopcroft, et al, 2006). These climate change factors could affect the range of EFH species, particularly Pacific salmon extending north and eastwards from the Bering and Chukchi seas and also affect the characteristics of freshwater waterbodies in winter.

The effects of a very large oil spill in the Chukchi Sea as set out in this analysis would overlap for the most part with the discussion of the effects on fish in Section IV.E.5. The major factors that would cause negative effects on EFH are provided for each Phase and summarized in Table C-1 in Appendix C.

Phase 1 (Initial Event)

An explosion and fire in or near marine EFH could directly impact all life stages of Arctic cod (and in particular their eggs and larvae), all life stages of saffron cod, and adult and late juvenile salmon. Direct impacts of an explosion and fire are not expected to reach opilio crab EFH.

Phase 2 (Offshore Oil)

Released oil and gas could impact marine EFH at the surface and subsurface.

Phase 3 (Onshore Contact)

Oil could contact estuarine and freshwater EFH used for spawning, rearing and overwintering.

Phase 4 (Spill Response and Cleanup)

Response and cleanup efforts can impact EFH through vessel and drilling noise, seismic surveys for response activities, human activity in estuarine and freshwater EFH critical to spawning and rearing, and use of dispersants.

Phased 5 (Long Term Recovery)

The long-term presence of weathering oil (and possibly dispersant residue) in marine, estuarine and freshwater EFH can cause lasting adverse impacts.

Appendix C, Figures C-1, C-6, C-7, and C-8 display the marine and freshwater EFH of these species. Table 12 presents a summary of effects on EFH of five phases of a very large oil spill described in the scenario in this document. The effects on a particular EFH species would vary depending on the location of the spill (see OSRA analysis of EFH below) and the time of the year (reproductive cycle of the species). The table summarizes the possible effects over the full year of seasons.

Table 12. The effects of a VLOS on EFH of Arctic cod, saffron cod, opilio crab and salmon in the Alaska Chukchi Sea.

Phase	Arctic Cod EFH	Saffron Cod EFH	Opilio Crab EFH	Salmon EFH
Phase 1 Explosion and Fire	All life stages, particularly eggs and larvae	All life stages	(EFH out of range of explosion)	Adult and late juvenile
Phase 2 Offshore Spill	All life stages, particularly eggs and larvae	All life stages	All life stages	Adult and late juvenile
Phase 3 Onshore Contact	(no onshore life stage)	(no onshore life stage)	(no onshore life stage)	All life stages
Phase 4 Response, Clean-up	All life stages, particularly eggs and larvae	All life stages	All life stages (minimal contact of EFH)	All life stages
Phase 5 Long-term Recovery	All life stages	All life stages	All life stages (minimal contact of EFH)	All life stages

Some EFH may be more vulnerable to a VLOS than others. Salmon freshwater and estuarine EFH used for spawning and rearing would be very vulnerable and have a very high potential for major effects, especially during spring and summer. Young salmon use estuaries and shallow coastal waters as rearing and feeding grounds and migration areas (Costello, Elliott, and Thiel, 2002; Elliott, 2002). 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. Juvenile salmon would also be vulnerable offshore in the pelagic EFH. Moss et al. (2010) trawled high densities of juvenile pink and chum salmon in the offshore pelagic environment of the Chukchi Sea in September, 2007.

Arctic cod pelagic environment EFH would have a very high potential for major effects, particularly if a spill occurred in winter when adults were spawning under-ice and eggs and larvae were developing. Arctic cod eggs float and therefore inhabit the microlayer of the sea where important physical, chemical and biological processes take place. Individuals and schools of adult and juvenile Arctic cod in the epipelagic EFH would be vulnerable to contact with a spill. If the oil/gas release occurred at the seafloor, adult and juvenile Arctic cod in the demersal EFH could be affected immediately and in the longer term if oil were entrained in the water column or sediments.

Saffron cod nearshore adult and juvenile EFH would have a very high potential for major impacts if a very large oil spill came towards shore and dispersants were used to break up and sink the oil particulate.

Opilio crab EFH would be most affected by an offshore spill that drifted south and east, contacting egg, adult and late juvenile EFH in the region of Kotzebue Sound.

Oil Spill Trajectory Analysis

The following subsection describes the range estimated by the OSRA model expressed as percentage of trajectories that will contact some part of Essential Fish Habitat from LA1-LA13.

Opilio Crab EFH

Offshore Oil Spill and Onshore Contact (Phase 2-3). Summer 60 Days: The OSRA model estimates that <0.5 – >99.5% of the trajectories from LAs 4, 9 and 10 would contact Opilio Crab Essential Fish Habitat EFH. The model estimates that <0.5% of the trajectories from the other Launch Areas would contact Opilio Crab. LA 9 overlaps a portion of opilio crab EFH, and therefore percentage of trajectories is up to >99.5% (Table 13; Appendix C, Figure C-8).

Summer or Winter 360 Days. The OSRA model estimates that <0.5 – >99.5 % of the trajectories from LAs 4, 9 and 10 would contact Opilio Crab Essential Fish Habitat (EFH) . The model estimates that <0.5% of the trajectories from the other LAs would contact Opilio Crab EFH within 360 days during summer or winter. LA9 overlaps a portion of opilio EFH and, therefore, the percentage of trajectories is up to >99.5% (Table 13).

Table 13. Range of fractions of a Very Large Oil Spill (expressed as percentages) starting from a given location that will contact a portion of Opilio Crab EFH within 60 or 360 days.

Season / Analysis Period	Percentage from LA4*	Percentage from LA9	Percentage from LA10
Summer 60 Days	<0.5 – 1	<0.5 - > 99.5	<0.5 – 2
Summer 360 Days	<0.5 – 1	<0.5 - > 99.5	<0.5 – 2
Winter 360 Days	<0.5 – 1	<0.5 - > 99.5	<0.5 – 1

* All other LAs over the three time periods have <0.5% of trajectories contacting. Launch Area 9 overlaps with opilio EFH, and therefore is up to >99.5%.

Saffron Cod EFH

Summer 60 Days. The OSRA model estimates that <0.5 – >99.5% of the trajectories from LAs 1-13 would contact Saffron Cod Essential Fish Habitat (EFH). The LAs 9, 12 and 13 overlap a portion of saffron cod EFH, and therefore is up to >99.5% (Table 14, below; Appendix C, Figure C-7).

Summer and Winter 360 Days. The OSRA model estimates that <0.5 – >99.5% of the trajectories from LAs 1-13 would contact Saffron Cod Essential Fish Habitat (EFH) within 360 days during summer. The LAs 9, 12 and 13 overlap a portion of saffron cod EFH, and therefore is >99.5% (Table 14; Appendix C, Figure C-7).

Table 14. Range of fractions of a VLOS (expressed as percentages) starting from a given location that will contact a portion of Saffron Cod EFH within 60 or 360 days.

Season / Analysis Period	LAs 1-5 (%)	LAs 6,7,8 (%)	LAs 10,11 (%)	LAs 9, 12,13 (%)
Summer 60 Days	<0.5 – 2	<0.5 – 4	<0.5 – 9	<0.5 – >99.5
Summer 360 Days	<0.5 – 3	<0.5 – 8	<0.5 – 9	<0.5 – >99.5
Winter 360 Days	<0.5 – 5	<0.5 – 4	<0.5 – 8	<0.5 – >99.5

*LAs 9, 12 and 13 overlap with saffron cod EFH, and therefore the results are up to >99.5%.

Salmon-Marine EFH and Arctic Cod EFH

Summer within 60 Days, Summer within 360 Days, and Winter within 360 Days. The OSRA model estimates that up to >99.5 % of the trajectories from LA1-LA13 would contact Arctic cod and saffron cod Essential Fish Habitat (EFH) within 60 days and 360 days during summer and 360 days during winter. All LAs (1-13) overlap Arctic cod and salmon (marine) EFH, and therefore is up to >99.5% (Table 15, below; Appendix C, Figures C-1 and C-6).

Table 15. Range of fractions of a VLOS (expressed as percentages) starting from a given location that will contact a portion of Arctic cod or salmon (marine) EFH within 60 or 360 days.

Launch Areas*	Summer 60 Days Percent (%)	Summer 360 Days Percent (%)	Winter 360 Days Percent (%)
1-13	<0.5 – >99.5	<0.5 – >99.5	<0.5 – >99.5

LAs 1-13 overlap salmon (marine) and actic cod Essential Fish Habitat; and therefore percentages are up to >99.5%.

Shoreline Habitat Contacted

It is estimated that between 0 and 1,368 km of discontinuous shoreline length could be contacted by oil trajectories in the Chukchi Sea depending on the location of a very large oil spill, the season and the number of days after the spill release. The type of shoreline that would be contacted along the Chukchi coast includes salt and brackish water marshes, mixed sand and gravel beaches and fine to medium sand beaches. These types of shorelines are considered "most sensitive" to oil contact and oil persistence in the Environmental Sensitivity Index (NOAA-ORR, 2011).

Conclusion

The level of effects of a very large oil spill in the Chukchi Sea on Essential Fish Habitat would depend on several factors including:

- location of the oil spill (nearshore, further offshore); depth at which the release occurs (seafloor, mid-column or surface), ratio of the mixture of oil and gas released, and time of year oil spill occurs
- extent and location of spawning areas in the estuarine or riverine systems
- species abundance and distribution (widespread, rare)
- the species and the sensitivity of their life stage affected (egg, larvae, juvenile, adult)
- life history and reproductive cycle

Considering these factors, EFH of some species’ life stages could be significantly impacted.

The EFH of the following species and life stages would be particularly vulnerable: Arctic cod (eggs, larvae, juveniles, adults); pink and chum salmon (eggs, larvae, juveniles, adults); and saffron cod (eggs, juveniles, adults). Opilio crab (eggs, juveniles, adults) would be less vulnerable due to the location of the EFH on the southern edge of the possible oil spill launch areas. Coho salmon (juveniles, adults), sockeye salmon (juveniles, adults) and king salmon (juveniles and adults) EFH would be less vulnerable to a very large oil spill in the Chukchi Sea due to the distribution of the species at its far northern range (Appendix C, Table C-1).

Of the eight EFH ecosystem component species listed in the Arctic Fishery Management Plan, 6 could be affected by a very large oil spill in the Chukchi Sea. Yellowfin sole, Alaska plaice, starry flounder and Bering flounder are widely distributed, however, they are relatively poor benthic swimmers and would be less able to escape oil or gas effects. Capelin and rainbow smelt are also widespread but depend on nearshore habitat for reproduction and therefore those life stages could be affected.

The selection of Alternative III or IV (coastwise corridor deferrals), which include parts of LAs 8-13, would reduce the chance of a very large spill contacting important nearshore, estuarine, intertidal and riverine habitats used by salmon, saffron cod and Arctic cod. Direct effects of an oil spill would be reduced on anadromous, migratory, nearshore and estuarine fish and their populations. The larger deferral associated with Alternative III has greater potential to reduce nearshore impacts as compared with Alternative IV.

IV.E.7. Cetaceans

A VLOS (very large oil spill) originating in the Chukchi Sea Planning Area could affect cetaceans (i.e. whales, dolphins, and porpoises) in a variety of ways. While all cetacean species that use the Chukchi Sea do so at least seasonally, and perhaps year round, distribution and habitat selection are often species specific, which may put some species at greater risk of contact (depending on the location, timing, and season) with oil from a VLOS. The biology and population status of each cetacean species is described in detail in Sections III.B.4.a. and III.B.6.b. of the Sale 193 FEIS (incorporated by reference) and is further supplemented in Chapter III of this SEIS. Therefore, biology and population status are not discussed here.

Effects of a VLOS on each cetacean species are discussed below for each of the five phases of the hypothetical scenario. Phase 2 (Offshore Oil) has the greatest potential for effects. Three ESA listed endangered whales (bowhead, fin and humpback whales), five unlisted species of cetaceans (gray, minke, beluga, and killer whales and harbor porpoise) and their associated habitats occur in the sale area. Refer to Section IV.C.1.f(1)(g) (pp. IV-114 to IV-122) of the Sale 193 FEIS for detailed discussion of the potential effects of oil on endangered whales and Section IV.C.1.h(4) (pp. IV-157-IV-161 for unlisted species of cetaceans). During the response to a VLOS, the response contractor(s) would be expected to work with NMFS and state officials on marine mammal management activities. In an actual spill, the two aforementioned groups most likely would have a presence at the Incident Command Post to review and approve proposed activities and monitor their impact on marine mammals. As a member of the team, NMFS personnel would be largely responsible for providing critical information affecting response activities to protect marine mammals. Specific marine mammal protection activities would be employed as the situation requires and would be modified as needed to meet the current needs. In all cases long-term recovery to pre-spill abundance, distribution, and productivity is likely, but recovery period would be variable and require access to unaffected/restored habitat during the period of recovery.

Phase 1 - Initial Event

Phase 1 of the hypothetical VLOS scenario encompasses a well-control incident resulting in a blowout and its immediate consequences. For all species considered, this Phase would cause only negligible, temporary, non-lethal adverse effects on cetaceans, with the exception of individuals experiencing Permant Threshold Shift hearing injuries or injury or mortality to individuals within a very small radius around an underwater blowout. This phase does not consider the release of oil or the effects of supporting aircraft or vessels; these will be discussed in Phase 2 and Phase 4 respectively. Potential IPFs (impact producing factors) and associated effects on cetaceans from Phase 1 include the following:

Explosion. Natural gas released during a blowout could ignite, causing an explosion. An explosion from the ocean bottom or within the water column would create a single pulse sound event that could injure cetacean hearing, depending on sound levels. It is possible that any individual cetaceans within the vicinity could experience Temporary Threshold Shift (TTP) or Permanent Threshold Shift (PTS). PTS would be considered a permanent injury, decreasing the ability of an individual to function in their environment and, ultimately, leading to declining health and potential mortality. However, most cetaceans tend to avoid active drilling rigs and associated operations and, therefore, it is unlikely that individuals would be close enough to an explosion to experience TTS or PTS. However, those cetaceans which may be present at greater distances from the drilling vessel could still experience some level of adverse impacts. The explosion could cause non-lethal and temporary effects in the form of a startle response. Startle events (McCauley, 2000) may cause cetaceans to display short-term avoidance activity such as change of swim direction and/or speed that may be accompanied by short-term endocrine response. Injury or mortality could occur in individuals within a very small radius of an underwater blowout event.

Fire. A blowout could result in a fire. The fire would remain localized as would potential suppression response activities once on site. Negligible effects are likely as cetaceans would likely remain at avoidance distances from the active drilling/blowout and fire response noise and activity. A rig fire resulting from an accidental event poses no threat to cetaceans because cetaceans would be expected to be beyond the avoidance distances from active rig noise if a fire event occurred, and would continue to avoid the immediate area of a rig fire in response to emergency suppression and fire response vessel and aircraft activities.

Re-distribution of Sediment. A blowout could re-distribute discharged drilling muds into the water column to be suspended there and/or to be deposited on the seafloor in a pattern reflecting currents, temperature, and other oceanographic factors. Localization of sediment re-distribution is negligible relative to the amount of sea floor available to cetaceans and the food sources that may be found or produced on or near the sea floor in the Chukchi Sea.

Sinking of Rig. The localized nature of a rig that sinks is negligible to cetaceans in terms of a hazard to movement or accidental contact with hazardous materials or structures associated with a sunken rig. Petroleum or other chemical compounds may be introduced to the marine environment from the damaged rig. These compounds, with the exception of a VLOS, would be limited in quantity, rapidly diluted (if soluble), float, sink and be deposited on the sea floor or recovered and disposed of. Depending on the nature of the compound, localized fate of the compound, and capability for clean up of surface or sea bottom materials, a negligible impact to cetaceans is likely. Most cetaceans would remain at avoidance distances away from the local rig site operations and noise when received sounds are strong, but not when sounds are barely detectable (Richardson et al., 1995:284-289).

Phase 2 - Offshore Spill

Phase 2 of the scenario focuses on the continuing release of oil into offshore and nearshore waters. Of all the phases, the Offshore Spill has the greatest potential to adversely affect cetaceans and their habitats. More severe impacts could also occur, and in some cases cetaceans may require three or more generations coincident with restored and unaffected habitat to restore distribution and populations.

Below are potential IPFs associated with Phase 2 that have the potential to affect cetaceans.

Contact with Oil. Cetaceans could experience adverse effects from contact with hydrocarbons, including:

- Inhalation of liquid and gaseous toxic components of crude oil and gas.
- Ingestion of oil and/or contaminated prey.
- Fouling of baleen (bowhead, fin, humpback, minke, and gray whales).
- Oiling of skin, eyes, and conjunctive membranes causing corneal ulcers, conjunctivitis, swollen nictitating membranes and abrasions.

Contamination. Impacts may include ingestion of contaminated prey (prey that have consumed or absorbed oil fractions that remain in their bodies) and/or reduction of food source. Pollution stemming from an oil spill may contaminate environmental resources, substrates (water, air, and sediments), habitat, and/or food sources. Contamination may also cause mortality and or contamination of food sources during the long term (multi year) and short term (current year production, ice and oceanographic cycles).

Loss of Access (Disturbance and Displacement). Cetaceans may be displaced from feeding areas, migration routes, and critical life function habitats. The latter include areas critical to the maintenance of individuals and populations, including birthing, feeding, breeding, migration, rearing/nursing, and resting. Moreover, whales may lose access to feeding areas or to areas where prey concentrate due to avoidance of spilled oil—displacement, or movement away. For further discussion see the Sale 193 FEIS (USDOI, MMS, 2007a).

This analysis will address each of these potential effects for each species of cetaceans using the Chukchi Sea.

Bowhead Whale

Bowhead whales migrate in spring through the Chukchi Sea to summer feeding areas and in fall to the Bering Sea wintering area with a relatively small number possibly staying in the Chukchi Sea throughout the summer (Moore and Reeves 1993, Brueggeman 1992). The spring migration is well documented with whales following the open leads in the sea ice running parallel to the Chukchi Sea coastline before veering eastward through the Beaufort Sea (Braham et al. 1984; Moore and Reeves 1993). Most whales pass through the Chukchi Sea by late June as documented from traditional environmental knowledge (TEK) and research (Huntington and Quakenbush 2009). TEK indicates that the spring migration occurs earlier than in the past (Huntington and Quakenbush 2009).

Since 2006, the fall migration has been more specifically documented by tracking 20 satellite-tagged bowhead whales from Barrow through the Chukchi Sea into the Bering Sea (Quakenbush et al., 2009). Most of the whales migrated westward above 71º N latitude from Barrow to Wrangel Island and then down the Chukotka Coast before entering the Bering Sea. Some whales apparently migrated in a more southwesterly direction from Barrow to the Chukotka Coast, crossing through or near the survey areas (Quakenbush, Small, and Citta, 2010). Aerial and vessel surveys conducted in the Chukchi Sea in the 1980s and 1990s also suggest a southwesterly route based on scattered bowhead whale sighting locations (Ljungblad et al., 1984, 1986, 1987; Brueggeman et al., 1991, 1992; and others). Recent acoustic studies conducted from 2007 to 2009 indicated calling bowheads migrated across the Chukchi Sea in both a westerly direction following the 71° N latitude and a less defined route after leaving the Barrow area (Hannay et al., 2009; Martin et al., 2008). Eskimo whalers report whales travel westward and later during light ice years and southwestward during heavy ice years (Figure 26 in Huntington and Quakenbush, 2009). These collective results suggest the location of the fall migration route may comprise a variety of paths dispersed widely across the Chukchi Sea. The fall migration of bowheads through the Chukchi Sea generally begins in early October and ends sometime in December, as sea ice advances into the Bering Sea.

Contact with Oil. Bowheads are the most likely of the ESA listed baleen whales to experience adverse effects of a VLOS as described in the hypothetical scenario. They commonly occur in areas of the Chukchi and Beaufort seas (Harwood et al., 2010) during spring and fall migrations, and could come into direct contact with spilled oil (Quakenbush, 2010a). Acoustic studies indicate some bowheads may inhabit the Chukchi Sea year-round; however, most pass through in the spring and fall during migration between the Bering Sea and Canadian Beaufort Sea (Moore et al., 2010). Calling bowheads have been recorded in the Chukchi Sea during summer and winter (Berchok et al., 2009, Funk et al., 2010). A recent acoustic study monitoring for bowhead calls in the western Beaufort Sea and northeastern Chukchi Sea between October and May reported calling bowhead whales during October and November but not again until late March (Moore et al., 2010), indicating most bowheads do not overwinter in this region. The presence (or absence) of bowhead whales in and adjacent to the lease area from December through March has not been confirmed through acoustic or other means of monitoring or observation. Bowheads may be present in this area during this time but would not be particularly vulnerable to adverse impacts as compared with any other time of year. Nothing indicates that the potential for adverse impacts in this case would differ between the action alternatives. Additional information on bowhead presence in the western Beaufort Sea and northeastern Chukchi Sea from December through March is not essential to a reasoned choice among lease sale alternatives.

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, including bowhead whales. Given the very low probability of a VLOS event occurring and affecting large numbers of cetaceans, and the fact that the overall potential for impacts would vary only slightly under each action alternative, additional studies on the potential effects of oil exposure on free-ranging marine mammal populations is not essential to a reasoned choice among lease sale alternatives. Nonetheless, evaluation of available science permits the application of scientific judgment regarding potential effects.

Available evidence suggests that mammalian species vary in their vulnerability to short-term damage from surface contact with oil and ingestion. While vulnerability to oil contamination exists due to ecological and physiological reasons, 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. The logistical, physical capability, technology and cost limitations that would provide data collection and evaluation of the potential for long-term sublethal effects on large cetaceans are prohibitive at this time. 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 Exxon Valdez oil spill (as with the disappearance of relatively large numbers of killer whales from the AB pod in Prince William Sound) (see Dahlheim and Matkin, 1994 and the following discussion), 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, predicting potential long-term sublethal (for example, reduced body condition, poorer health, reduced productivity, later sexual maturation, longer reproductive interval, or longer dependency periods) or lethal effects on cetaceans from a VLOS is difficult.

The greatest threat to large cetaceans is likely from the inhalation of the volatile toxic hydrocarbon fractions of fresh oil. Prolonged inhalation of volatile toxic hydrocarbon fractions of fresh oil induces severe adverse effects. 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). Bowhead mortality could occur if they surfaced and breathed repeatedly in the fresh oil of a VLOS and freshly evaporated toxic aromatic hydrocarbon compound vapors occur at the sea surface. Effects upon bowhead whales range from negligible to acute toxic poisoning resulting in endocrine system and organ impairment or death. Lighter-than-air aromatic vapors dissipate rapidly into the atmosphere. Heavier than air components may linger near the surface during periods of calm winds, but otherwise atmospheric mixing allows these vapors to dissipate rapidly. The dissipation of volatile components varies with temperature, wind, and characteristics of encapsulation of oil components into ice and the ice conditions that determine rate of release. Oil trapped in the mixed and fractured ice and interspersed open water characteristic of polynya systems allows for varying amounts of toxic aromatic components to evaporate and dissipate during the winter period before migrating bowheads arrive in the Chukchi Sea spring lead system.

Spilled oil that has aged to the point where initial evaporation of light toxic fumes is no longer present reduces the risk of prolonged inhalation exposure to toxic fumes.

Two situations of higher risk to bowhead whales could occur. These exceptions involve prolonged exposure of migrating or feeding bowheads to inhalation of volatile toxic components of fresh oil in the Chukchi Sea spring lead system during migration of the majority of the Western Arctic Bowhead population through the lead system and when feeding aggregations (such as those that occur northeast of Barrow in the fall) are similarly exposed to toxic fumes from a very large oil spill. During spring migration, females with newborn calves, whose movement is somewhat constrained by the polynya system, may endure exposure to some released toxic fumes from fresh oil trapped in ice since October 31 of the previous year to as late as January 4. It is likely that a major portion of the toxic fumes would have evaporated over the winter through the active cracks, ice movement, and movement through brine channels in the polynya ice cover when temperatures are at or above critical temperature (NOCOR, 1975; Fingas and Hollebone, 2003). Toxic fumes are likely to have dispersed in the atmosphere by May and early June, when most females with calves migrate through the Chukchi spring lead system, and would not pose a prolonged toxic exposure. If high toxic vapor levels should occur and prolonged exposure of females with calves occurs, mortality could result. Volatile toxic fractions may be particularly toxic to newborn calves that must take more frequent breaths and spend more time at the surface than their mothers. As unlikely as it may seem, such exposure is not beyond the range of possibilities, and depending on the timing and numbers of females with calves contacting toxic vapors of fresh oil, mortality of a large portion of a year's cohort of calves and perhaps some individual females and other age and sex classes could occur. Options to migrate through adjacent ice covered waters are fewer for newborns as compared to older animals that may or may not be able to detect the spill and exercise alternate migration routing options. These adults may travel through considerable areas of up to 100% ice cover, which appears to not limit bowhead distribution (Quakenbush, Small, and Citta, 2010). There are anatomical data and observations that bowhead whales have the olfactory organs (Thewissen et al., 2010) and ability to detect smoke from dumps and potentially spilled oil such that they may modify movements to avoid a large or very large oil spill. Spring migration could be delayed or deflected around spilled oil (females with calves, and other age and sex classes, may attempt to detour through adjacent ice covered waters around the spill and associated toxic fumes). Newborn calves—having short breathing intervals and less capability to break breathing spaces in ice cover while following their mothers—risk separation, abandonment or mortality. A portion of an annual cohort of newborn calves and some older individuals could potentially experience such mortality under those conditions. Depending on numbers of calves that might die, loss of an annual cohort would be reflected in an immediate reduction in population that may take several years to replace. Also, there may be in the future reduced contribution of the individual females and their progeny to recruitment into the breeding female population (these females would have become sexually mature in 18-20 years). The loss of the lifetime reproductive contribution of these females to the population could depress population rate of increase slightly for several decades.

Another circumstance whereby adverse effects could be experienced by large numbers of bowheads is when one or more large aggregations of bowheads contact a fresh oil spill (with high concentrations of toxic aromatic vapors) during the open water season. Aggregations of between 50 and 100 bowheads have been observed in some, but not all years, during BOEMRE and NMFS aerial surveys and particularly in the feeding area identified northeast of Barrow under bowhead feeding studies (Moore, George, and Sheffield et al., 2010).

Spilled oil appears to have limited impact on cetacean skin. 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. They observed groups of Dall's porpoises on 21 occasions in areas with light sheen, several occasions in areas with moderate-to-heavy surface oil, once in no oil, and once when they did not record the amount of oil. Thirteen of the animals were close enough to determine if oil was present on their skin. They confirmed that 12 animals in light sheen or moderate-to-heavy oil did not have oil on their skin. 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. Some temporary irritation or permanent damage to conjunctive tissues, mucous membranes, around the eyes, abrasions, conjunctivitis and swollen nictitating membranes could occur (Geraci and Smith, 1976b; Davis, Schafer, and Bell, 1960).

Ingestion. Ingestion of dissolved, suspended, or floating oil components while feeding on or near the surface could occur during the open water period, or if bowheads come into contact with oil in/on the seafloor during near-bottom feeding. Oil components or chemical oil dispersant derived compounds could be consumed by bowheads feeding on prey anywhere in contaminated water column layers to the sea floor. Bowheads may ingest oil fractions that sink to (and may persist in) the sea floor sediments that are disturbed when near-bottom feeding. Ingestion of petroleum hydrocarbons can lead to subtle and progressive organ damage or to rapid death in mammals. 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 the birth weight of young. While the potential effects on bowhead to exposure to polycyclic aromative hydrocarbons (PAHs) through their food are largely unknown, the very low probability of a VLOS event occurring and leading to widespread ingestion of PAHs, and the fact that the potential for such impacts would vary only slightly under each action alternative, means that additional studies of this potential are not essential to a reasoned choice among lease sale alternatives. That said, there currently exists information with pertinence to this issue. Oil ingestion can decrease food assimilation of prey eaten (for example, 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. 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. 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.

Temporary baleen fouling could also occur, but the light weight of the spilled oil probable for the Chukchi Sea is not as likely to adhere to and impair the hydraulic function of the baleen fibers as would more viscous, weathered or emulsified oil. Lighter oil should result in less interference with feeding efficiency. In a study in which baleen from fin, sei, humpback, and gray whales was oiled, Geraci (1988) 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 in some cases finer, than that of bowhead whales, whose longer baleen has many hairlike filaments. Lambertsen et al. (2005, p. 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. Geraci (1990) also pointed out the greatest potential for adverse effects on bowheads would be if spilled oil occurred in the spring lead system.

Contamination and Reduction of Food Sources. Data from a recent study (Duesterloh, Short, and Barron, 2002) indicated that aqueous polyaromatic compounds (PACs) 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 UV levels that are encountered in nature. *Calanus marshallae* exposed to UV in natural sunlight and low doses (~2µg of total PAC per liter 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 PACs 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, p. 3959).

The potential effects on bowheads of exposure to PACs through their food are unknown. Bowheads may swallow some oil-contaminated prey and ingest some dissolved or floating oil fractions incidental to food intake, 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 VLOS. Some zooplankton (eaten by bowheads) consume contaminated oil particles contained in their prey. 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. The probability that a VLOS would occur and affect bowhead whales through exposure to PACs or displacement from productive feeding areas is very small, and would vary only slightly under each action alternative. Additonal information on these subjects is therefore not essential for a reasoned choice among lease sale alternatives.

A VLOS 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 in a very large oil spill could be very small compared to what is available on the whales' summer-feeding grounds (Bratton et al., 1993). A VLOS, depending on the timing and location relative to the distribution and aggregations of zooplankton could reduce feeding opportunities for a majority of the bowhead population during that year. The significance of the loss of that opportunity to bowhead health is dependent upon major feeding opportunities bowheads may find later in the year to meet annual energy demands. Fate, recovery, and availability of zooplankton populations to bowheads in similar quantities and locations as pre-spill conditions in the Chukchi and western Beaufort seas in subsequent years would depend on a variety of factors, as is discussed in Section IV.E.4. Oceanographic and climatic factors combine to aggregate zooplankton in some areas. Sources, transport of, and year to year persistence of plankton populations utilized by bowhead whales in and adjacent to the sale area remain unclear.

While controlled studies of the potential effects on bowheads of exposure to PACs through their food remain infeasible at this time, bowheads are believed to be vulnerable to incremental long-term accumulation of pollutants given their extreme longevity. With increasing development within their range and long-distance transport of other pollutants, individual bowheads may experience multiple large and small polluting events, as well as chronic pollution exposure, within their lifetime.

Displacement From and Avoidance of Habitat. Scientists have not had the opportunity to observe bowhead response to a VLOS, and any displacement caused by subsequent spill response and cleanup operations. However, there are first-hand accounts of displacement effects on bowhead whales from a 25,000-gallon (595-bbl) oil spill at Elson Lagoon (Plover Islands) in 1944. Traditional knowledge provided by Tommy Brower, Sr (1980) explained that for the four years that oil was still present, bowhead whales made a wide detour out to sea when passing near Elson Lagoon/Plover Islands during fall migration. Bowhead whales normally moved close to these islands during the fall migration (when no oil was present). These observations indicate that some displacement of whales may occur in the event of a VLOS, 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. Anatomical data and observations that suggest that bowhead whales have the olfactory organs (Thewissen et al., 2010) and ability to detect spilled oil to such a degree that they may modify movements to avoid a VLOS.

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. During the spill of Bunker C and No. 2 fuel oil from the Regal Sword, researchers saw humpback and fin whales, and a whale tentatively identified as a right whale, surfacing and even feeding in or near an oil slick off Cape Cod, Massachusetts (Geraci and St. Aubin, 1990). Whales and a large number of white-sided dolphins swam, played, and fed in and near the slicks. The study reported no difference in behavior between cetaceans within the slick and those beyond it. None of these observations prove whether cetaceans can detect oil and avoid it, or whether long-term impacts occurred from exposure. Some researchers have concluded that baleen whales have such good surface vision that they rely on visual clues for orientation in various activities. In particular, bowhead whales have been seen “playing” with floating logs and sheens of fluorescent dye on the sea surface of the sea (Wursig et al., 1985, as cited in Bratton et al., 1993). These observations suggest that if oil is present on the sea surface and is of such quality or in such quantity that it is readily optically recognizable, bowhead whales may be able to recognize and avoid it (Bratton et al., 1993). However, the observation of their playing with dye may also indicate that they may not avoid spilled oil.

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.

The presence of oil could prevent or disrupt access to and displace whales from habitat areas. Depending on oceanographic and climatic variables, zooplankton food concentrations that may normally result in feeding aggregations of bowhead whales may not be available. A VLOS could displace feeding whales from an active feeding event(s) or cause whales to avoid an otherwise available aggregated food source and feeding opportunity. Depending on the specifics and magnitude of a lost feeding opportunity and its contribution to the annual energy and nutrient requirement of individual whales, adverse effects upon health and reproduction could occur. Situations where effects could be more important include impaired access to the relatively consistent food aggregations north east of Barrow and any large aggregations of food attracting and holding large numbers of whales for an extended period of time (from a few days to weeks). Loss of access and use of the spring polynya system by migrating bowhead and beluga whales could result in variable mortality of newborn bowhead calves, delayed migration, and/or migration route avoidance or deflection and redistribution of migrating and spring feeding whales to adjacent areas with greater ice cover. Depending on the specifics of a given event, mortality of a portion of an annual cohort of calves could result, which in turn, could have longer term effects on population level recruitment and reproduction. It could also result in modification of migration pattern effects, as well as shorter term adverse body condition and health effects.

In most cases, a VLOS event would occur at a time of year when the toxic fumes would dissipate into the atmosphere rapidly so as not to allow for prolonged exposure to the majority of whales in the open water and fall migration period. There is a potential that spilled oil could persist and be transported during ice covered seasons. A portion of the toxic volatile hydrocarbon fractions are likely to evaporate and dissipate into the atmosphere before remaining oil could be contacted by migrating bowheads during the next year. Thus, toxic fractions would occur in low enough densities to disallow prolonged (if any) exposure for cetaceans in the spring lead system. The northernmost portions of the spring lead system appear to be used by some spring migrating bowheads in the Chukchi Sea where contact with freshly spilled oil and fumes due to the shorter distance to an event site and shorter period that fresh oil has to age in the lead system could occur. There may be an opportunity for the individuals that have migration paths in those areas to be much closer to potential spill sites on existing leases, and they could be exposed to prolonged inhalation of toxic fumes if they do not exercise detection and avoidance responses. The potential for significant impacts to an annual cohort of the bowhead population could occur under a narrow set of conditional circumstances during the spring migration through the spring lead system in the Chukchi Sea and the far western Beaufort Sea.

Fin Whale

Fin whales are present only during the open water season in the Chukchi Sea. These whales occur rarely and as individuals or small groups within the Lease Sale 193 area (Funk et al., 2010); COMIDA, 2009; Roseneau, 2010), but are more frequently observed in waters of the southwestern Chukchi Sea adjacent to the Chukotka Peninsula, Russia. Fin whales are widespread and relatively abundant in the Bering Sea (Melinger et al., 2010). Since they are also baleen whales they may, upon contacting fresh spilled oil, experience effects similar to bowheads from inhalation, ingestion, baleen fouling, skin and conjunctive tissue irritation. Fin whales also may exhibit detection and avoidance of spilled oil. It is even possible that fin whales could be killed if they surfaced repeatedly 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 spills in Alaska, it is unlikely that large numbers of fin whales would be adversely affected by a VLOS in the Sale 193 area.

Because of their frequency of occurrence and distribution in the Russian Chukchi Sea, the primary additional potential adverse effect on fin whales could be from a large or VLOS that contacted waters adjacent to the Chukotka Peninsula in the southwestern Chukchi Sea. During the summer and fall, fin whales could potentially be negatively impacted by a VLOS that contacted the waters adjacent to the north side of the Chukotka Peninsula, especially near Cape Dezhnev in the summer.

Humpback Whale

Humpback whales are present during the open water season in the Chukchi Sea and far western Beaufort Sea. Humpbacks occur rarely and as individuals or small groups in and adjacent to the Sale 193 area. Humpbacks are more frequently observed in waters of the southwestern Chukchi Sea adjacent to the Chukotka Peninsula and are widespread and relatively abundant (Central North Pacific stock) in the eastern Bering Sea. Since they are also baleen whales they may, upon contacting spilled oil, experience similar inhalation, ingestion, baleen fouling, skin and conjunctive tissue irritation; but also may exhibit detection and avoidance of spilled oil as may bowhead and fin whales. Repeated surfacing within a VLOS with fresh oil with high levels of volatile toxic hydrocarbon fractions present could potentially lead to organ damage and/or mortality of humpbacks. These whales prey on schools of forage fish (capelin, sand lance, herring) species as well as copepods and euphausids in the water column and on or near the surface which may have spilled oil present. Consumption of contaminated prey, the reduction or mortality of local forage fish populations could create periods whereby summer prey would not be available for an undetermined time period depending on prey recovery rates and pioneering use of the restored prey. A negligible number of the Central North Pacific population of humpback whales would be expected to experience temporary and non-lethal effects from a VLOS within the Sale 193 area. However, if even some of the humpback whales in the Sale 193 and adjacent Chukchi Sea originate from the Western North Pacific stock (a smaller and less well-understood stock), the injury or loss of even an individual may be an important population level effect. Under such circumstances, three or more generations could be required to re-establish distribution and abundance in the Alaska Chukchi and Beaufort seas. Studying the EVOS, 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. 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.

Because of their distribution, the primary additional potential adverse effect on humpback whales could be from a VLOS that contacted waters adjacent to the Chukotka Peninsula in the southwestern Chukchi Sea. During the summer and fall, humpback whales could potentially be negatively impacted by a VLOS that contacted the waters adjacent to the north side of the Russian Chukchi Peninsula, especially near Cape Dezhnev in the summer. Given that the high Arctic environment is changing rapidly and the period of time when the Chukchi Sea is ice-free is increasing, we may expect increases in humpback whale use of this area in the foreseeable future. Should the Chukchi Sea become a routine part of the range of the humpback whales, potential impacts on the population from a VLOS would increase. As discussed in the 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 humpacks were negatively impacted by the EVOS (von Zeigesar, Miller, and Dahlheim, 1994); however, EVOS occurred before most humpbacks arrive for the summer in Prince William Sound.

Gray Whale

Gray whales summer in the Chukchi Sea where they feed before returning to wintering grounds in Mexico (Rugh et al., 1999, Rugh et al., 2001; Roseneau, 2010). Gray whales occupy the Chukchi Sea during the open water season, generally arriving behind the retreat of the sea ice and leaving ahead of the early winter advance of the ice (Clarke et al., 1989; Brueggeman et al., 1992; Funk et al., 2010; Goetz et al., 2009). Gray whales are the most abundant cetacean reported in the Chukchi Sea during summer (Funk et al., 2010; Brueggeman et. al., 1992). Gray whales are widespread in the Chukchi Sea but most occur near shore (< 40 km or 25 mi from shore) between Wainwright and Barrow with highest concentrations north and east of Wainwright. Recent acoustic data suggest some gray whales may over-winter in the Chukchi Sea (Stafford et al., 2007), but the numbers are likely small (Moore et al., 2000). Most occurred nearshore between Wainwright and Cape Belcher during both 2008 and 2009 survey seasons (Brueggeman, 2010). Gray whales observed during a shallow hazards survey conducted by CPAI (Conoco Phillips Alaska Incorporated) at Klondike prospect area and a coring program between Klondike and the coast in 2008 were entirely nearshore (Brueggeman et al., 2009). Similarly, the 2009 and 2010 COMIDA (COMIDA, 2009; 2010) surveys found most gray whales feeding nearshore between Pt. Lay and Barrow from June to October. Gray whale movements vary annually depending on prey abundance and distribution (Nerini, 1984). Gray whales feed in soft sediments which contain their primary prey: benthic ampeliscid amphipods (Nerini, 1984). Smaller numbers of gray whales historically concentrated in the region of Hanna Shoal, north and east of the Burger survey area between 160º and 165º W, but none were seen there during the 2009 and 2010 COMIDA surveys Clarke et al., 2011).

Contact with Oil. Gray whales are present in the Chukchi Sea and far western and eastern Beaufort Sea (Rugh, 1981; Moore, et. al. 2000) during the open water season, but there is acoustic evidence that individuals may spend the winter period in the Alaska Arctic as well (Stafford et al., 2007). These whales occur in shallow shelf nearshore and offshore shoal habitats to feed on benthic prey. They may, upon contacting spilled oil, experience effects from inhalation, ingestion, baleen fouling, skin and conjunctive tissue irritation, but also may exhibit detection and avoidance of spilled oil similar to whale species discussed earlier. Migrating gray whales show only partial avoidance to natural oil seeps off California.

Laboratory tests suggest gray whale baleen and possibly skin, may be resistant to oil damage. Gray whales exhibiting abnormal behavior were observed in oil after the EVOS in an area where fumes from the spill were very strong (J. Lentfer, cited in Harvey and Dalheim, 1994). Subsequently large numbers of gray whale carcasses were discovered. One of three of these had elevated levels of polycyclic aromatic hydrocarbons (PAHs) in its blubber. Loughlin (1994) concluded it was unclear what caused the death of the gray whales. An estimated 80,000 barrels of oil may have entered the marine environment off Santa Barbara in 1969, when gray whales were beginning the annual migration north. Whales were observed migrating through the slick. Subsequently, six dead gray whales were observed and recovered as well as a number of other marine mammals. No evidence of oil contamination was found on any of these whales. The Battelle Memorial Institute concluded the whales were either able to avoid the oil, or were unaffected when in contact with it.

Based on all available information, if individual, small or large groups of gray whales were exposed to large amounts of fresh oil from a VLOS, especially through inhalation of highly toxic aromatic fractions, they might be seriously injured or die from such exposure. Although there is little definitive evidence linking cetacean death and serious injury to oil exposure, the deaths of large numbers of gray whales coincided with EVOS and observations of gray whales in oil. If fresh oil from a VLOS contacted important coastal or shoal habitats, the gray whale population could be at risk for multiple cases of injury or mortality when concentrated on summer feeding grounds, and could have limited options to avoid a spill and still meet annual nutrient and energy requirements in the Chukchi. Recovery of distribution, abundance, and habitats may take decades to recover or possibly more than three generations.

Ingestion. Gray whales may ingest oil fractions that sink to (and may persist in) the sea floor sediments that are disturbed when bottom feeding on benthic invertebrates, as is characteristic of the gray whale. Chronic consumption of bottom accrued oil fractions or contaminated prey may result in impaired endocrine function, reproductive impairment, or mortality. Baleen whales may have the capability to metabolize ingested oil compounds.

Contamination and Reduction of Food Sources. In the Chukchi Sea spilled oil could adversely effect gray whales by contaminating benthic prey and sediments (please refer to Section IV.E.4, Lower Trophic Organisms), particularly in prime feeding areas (Wursig, 1990; Moore and Clark, 2002). Any perturbation, such as a VLOS, which caused extensive mortality within a high latitude amphipod population with low fecundity and long generation times would result in marked decreases 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 Cadis oil spill in 1978 (approximately 70 million gallons). Ten years after the spill, amphipod populations had recovered to 39% of their original maximum densities (Dauvin, 1989, as cited by Highsmith and Coyle, 1992). Chukchi sea amphipod populations with longer generation times and lower growth rates, probably would take considerably longer to recover from any major population disruption (Highsmith and Coyle, 1992).

Displacement From and Avoidance of Habitat. Reduction or mortality in benthic prey larval stages that live in the water column, reduced benthic biomass, and productivity of near shore and offshore shoals may force gray whales to seek alternate, less optimal foraging areas of the shelf offshore for up to several years until nearshore or shoal benthic communities recover. Impacts to these whales could occur over a period of years depending on numbers and amounts of oil fractions chronically consumed or reduced from a VLOS and the quality and availability of alternate feeding habitat in the Alaska Arctic. Restoration of distribution and abundance of gray whales along the Alaska Chukchi Sea coast could take more than three generations to recover from a VLOS.

Minke Whale

Contact with Oil. These whales occur regularly in low numbers in the Chukchi Sea and Beaufort Sea during the open water season only (Ireland et al., 2008; Funk et al., 2010; Brueggeman, 2010; Roseneau, 2010). These whales are observed commonly as individuals or small groups. Minke whales may, upon contacting spilled oil, experience inhalation, ingestion, baleen fouling, skin and conjunctive tissue irritation similar to other whales, but also may exhibit detection and avoidance of spilled oil. Temporary and/or permanent, non-lethal injury could occur. When considering the numbers projected for the North Pacific and the potential numbers in the Alaska Arctic, population level effects are not anticipated; however, abundance, distribution patterns and frequency of occurrence in the Alaska Chukchi Sea could be reduced in response to possible reduction in abundance and distribution of prey resources. Recovery of minke whale to pre-spill abundance and distribution may be most dependent upon prey recovery timeframes.

Ingestion. Minke whales prey on schools of forage fish (capelin, sand lance, and herring) species as well as copepods and euphausids in the water column and on or near the surface which may have spilled oil present. Consumption of contaminated prey, the reduction or mortality of local forage fish populations could create periods whereby summer prey would not be available for an undetermined time period depending on prey recovery rates and pioneering use of the restored prey (see Section IV.E.5, Fish Resources). Compared to the Alaska stock/population of minke whales, a small number venture north of the Bering Strait and into the Chukchi Sea and the sale area. Minke whales contacting oil could experience temporary and non-lethal effects within the Sale 193 area.

Contamination and Reduction of Food Sources. These whales prey on schools of forage fish species (see IV.E.5, Fish Resources), as well as copepods and euphausiids in the water column and on or near the surface which may have spilled oil present. Oil contacted whales would likely experience minor temporary and non-lethal effects similar to those described for humpback whales. When considering the numbers projected for the North Pacific, population level effects are not anticipated.

Displacement From and Avoidance of Habitat. Minke whales may be able to detect and choose to avoid a VLOS, causing displacement to other habitat areas that may or may not be as optimal as those affected by a VLOS. Impacts to the distribution and abundance of prey, if they should occur, would largely determine the seasonal distribution and habitat use by minke whales. When considering the numbers projected for the North Pacific, population level effects are not anticipated; however, distribution and abundance in the Chukchi Sea could be modified or reduced in relation to the potential modification to food source distribution and abundance as result of a VLOS.

Beluga Whale

Beluga whales of three different stocks use habitats from along the Alaska Chukchi Sea coastline seaward to beyond the shelf break. The distribution of these stocks are seasonal, wintering in the Bering Sea and migrating to summer habitats in the Canadian Beaufort, Alaskan Beaufort and Chukchi Seas (Suydam, et al, 2001; Suydam et al., 2005; Roseneau, 2010). Some belugas migrate through the Chukchi spring lead system concurrent with the bowhead migration during April through June. Summer aggregations of molting belugas and females with calves occur in coastal lagoons and there is apparently habitat preference for waters near the continental shelf edge during summer and fall.

Contact with Oil. Contamination of the spring ice lead system from a VLOS could result in direct contact with spilled oil. Notable increased vulnerability of belugas exists in spring and early summer when concentrations occur in the warm shallow waters of Kasegaluk Lagoon to molt. Concentrations of large numbers of beluga whales are observed in some years in unpredictable places and numbers. In July of 2010 650+ belugas were observed for a number of days in Elson Lagoon north of Barrow (Monnett, 2010; NMFS, 2011). Belugas are present in the Chukchi Sea and far western Beaufort Sea during the open water season offshore as well as in coastal lagoons (Suydam et al., 2001; Suydam et al., 2005, and Ireland et al., 2009). Summer and fall observations indicate concentrations of belugas along and beyond the shelf edge, fall migration along the shelf edge, and some use throughout the shelf areas in the Chukchi and Beaufort Seas. There is acoustic evidence that some individuals may spend the winter period in the Alaska Arctic as well. They may, upon contacting spilled oil, experience similar inhalation, ingestion, skin and conjunctive tissue irritation similar to other whales, and also may exhibit detection and avoidance of spilled oil. Substantial injury and mortality due to physical contact inhalation and ingestion is possible to beluga whales, especially calves of the year and juveniles using habitats along the Alaska Chukchi Sea coast and the shallow lagoons situated there. Restoration of seasonal use patterns and abundance could take multiple generations and the potential for no recovery exists, depending on the extent of injury and mortality experienced. DFO (2010) indicates the factors and potential causes that may be hindering the recolonization of historic St. Lawrence beluga habitats after habitat degradation and loss of learned site fidelity through overharvest and extermination.

Ingestion. Beluga whales prey on fish (Arctic cod, saffron cod, herring, pollock) species as well as large copepods in the water column and on or near the surface which may have spilled oil present. Consumption of contaminated prey, the reduction or mortality of local forage fish populations could create periods whereby summer prey would not be available for an undetermined time period depending on prey recovery rates and pioneering use of the restored prey. The fish populations in lagoons along the Chukchi coast used by belugas for migration, moulting and nursing are vulnerable to oil contamination and subsequent ingestion by large numbers of beluga whales (see Section IV.E.5, Fish Resources).

Oil components or chemical oil dispersant derived compounds could be consumed by belugas feeding on prey anywhere in contaminated water column layers to the sea floor. Belugas may ingest oil fractions from contaminated prey items. Ingestion of petroleum hydrocarbons can lead to subtle and progressive organ damage or to rapid death in mammals. 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 the birth weight of young. Oil ingestion can decrease food assimilation of prey eaten (for example, 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. Wilson et al. (2005) examined CYP1A1 protein expression immunohistochemically in multiple organs of beluga whales from two locations in the Arctic and from the St. Lawrence estuary. These beluga populations have some of the lowest (Arctic sites) and highest (St. Lawrence estuary) concentrations of PCBs in blubber of all cetaceans. Cytochrome P450 1A1 (CYP1A1) is induced by exposure to polycyclic aromatic hydrocarbons (PAHs) and planar halogenated aromatic hydrocarbons (PHAHs) such as non-ortho polychlorinated biphenyls (PCBs). The systemic high-level expression of CYP1A1 in Arctic beluga suggests that effects of PAHs or PHAHs may be expected in Arctic populations. The high-level expression of CYP1A1 in the Arctic beluga suggests that this species is highly sensitive to CYP1A1 induction by aryl hydrocarbon receptor agonists. Samples from these populations might be expected to have different contaminant-induced responses, reflecting their different exposure histories. The pattern and extent of CYP1A1 staining in whales from all three locations were similar to those seen in animal models in which CYP1A has been highly induced, indicating a high-level expression in these whales. CYP1A1 induction has been related to toxic effects of PHAHs or PAHs in some species. The systemic high-level expression of CYP1A1 in Arctic beluga suggests that effects of PAHs or PHAHs may be expected in Arctic populations, as well. The high-level expression of CYP1A1 in the Arctic beluga suggests that this species is highly sensitive to CYP1A1 induction by aryl hydrocarbon receptor agonists.

Contamination and Reduction of Food Sources. Abundance and distribution may be modified or reduced in near shore areas in response to prey (fish and large copepods) reduction and contamination resulting from a VLOS. Prey recovery periods would determine recovery periods for beluga whale distribution and abundance to pre-spill levels (see Section IV.E.5, Fish Resources).

Displacement From and Avoidance of Habitat. The presence of oil could displace belugas from, prevent or disrupt access to affected habitat areas. The loss of nearshore and lagoon habitats by beluga females with calves and juveniles for nursing and molting, depending upon the extent of injury or mortality experienced may not be recoverable or take multiple generations to recover the use and abundance of whales using these seasonally important habitats. Impacts to the distribution and abundance of prey, if they should occur, would largely determine the seasonal distribution and habitat use by belugas.

Killer Whale

Killer whales have been observed in the Chukchi Sea during various surveys and other observations (Funk et al., 2010, 2011; George and Suydam, 1998; Roseneau, 2010). Killer whales have been primarily observed near the coast rather than farther offshore (Brueggeman et al., 1992, George and Suydam 1998; Roseneau, 2010), but this could be due to higher levels of human activity and observation opportunity nearshore. Conversely, acoustic recorders detected killer whale calls in 2007 and 2009 offshore between Cape Lisburne and Barrow from July until October (Delarue and Martin, 2010; Hannay et al., 2009; Martin et al., 2008). The combination of acoustic and visual data suggests killer whales occur both offshore and near shore with no clear inshore/offshore trend.

Contact with Oil. Killer whales are observed infrequently by Native hunters and others in very low numbers throughout the Alaska Chukchi and western Beaufort Seas (Frost et al., 1983; Lowry et al., 1987; Brueggman et al., 1992 as cited in Brueggeman, 2009; Roseneau, 2010). Russian observations along the southwestern Chukchi Sea along the Chukotka Peninsula coast indicate greater abundance of killer whales in that area. They may, upon contacting spilled oil, experience inhalation, ingestion, skin and conjunctive tissue irritation similar to whales discussed earlier, and also may exhibit detection and avoidance of spilled oil. Matkin et al. (1994) reported killer whales had the potential to contact or consume oil, because they did not avoid oil or avoid surfacing in slicks. In the two years following EVOS, significant numbers (13) of individual whales, primarily reproductive females and juveniles, disappeared from the AB pod. Dahlheim and Matkin (1994) observed AB pod members swimming through heavy slicks of oil and 18 killer whales including 3 calves surface in a patch of oil. They concluded that there is a spatial and temporal correlation between loss of the whales and the EVOS, but there is no clear cause-and-effect relationship. Matkin et al. (2008) note the synchronous 33% and 41% initial losses from the AB Pod and the AT1 Group in the year following the EVOS, and that 16 years post spill the AB has not recovered to former numbers and the AT1 Group has continued to decline and is now listed as depleted under the MMPA. The synchronous losses of unprecedented numbers of killer whales from these two genetically and ecologically separate groups and the absence of other obvious perturbations strengthens the link between mortalities and the lack of recovery and the EVOS. The link, however, remains circumstantial and there is not agreement among the scientific community as to whether or not there likely was an oil-spill impact on killer whales after the EVOS.

Contamination and Reduction of Food Sources. The killer whales in the Alaska Arctic are likely marine mammal predators as suggested by the few accounts of predation documented (George and Suydam, 1998). The fate of other marine mammals, and of potential prey fisheries, in detection and avoidance of a VLOS, declining or contaminated food sources causing redistribution, injury, contamination and fluctuations in prey numbers, and recovery of prey post spill will determine the persistence and use of the Sale 193 area and adjacent areas. As an apex predator, killer whales could bioaccumulate petroleum residues in tissues. While they indicate some ability to metabolize hydrocarbon factions ingested or otherwise absorbed, they also indicate sensitivity to CYP1A1 induction by hydrocarbon receptors; however, abundance, distribution patterns and frequency of occurrence in the Alaska Chukchi Sea could be reduced in response to possible reduction in abundance and distribution of prey resources (Wilson et al., 2005). Recovery of killer whale to pre-spill abundance and distribution would be dependent upon prey (marine mammals and fisheries) recovery timeframes.

Displacement from and Avoidance of Habitat. No clear patterns of habitat use have merged from killer whale observations in the Alaska Arctic. The fate of other marine mammals (prey base for killer whales in the Arctic) in detection and avoidance of a VLOS, declining or contaminated food sources causing redistribution, injury or mortality, contamination and fluctuations in prey numbers, and recovery of prey post-spill will determine the persistence and use of the LS 193 area and adjacent areas. Odonocetes (toothed whales) do not seem to consistently avoid oil, although they can detect it (Geraci, 1990). Matkin et al. (1994) reported killer whales had the potential to contact or consume oil, because they did not avoid oil or avoid surfacing in slicks. In the two years following EVOS, significant numbers (13) of individual whales, primarily reproductive females and juveniles, disappeared from the AB pod. Dahlheim and Matkin (1994) observed AB pod members swimming through heavy slicks of oil and 18 killer whales, including 3 calves, surfaced in a patch of oil.

Harbor Porpoise

Harbor porpoise are recorded in the Chukchi Sea and Barrow areas (Suydam and George. 1992; Roseneau, 2010) and by surveys in the northeastern Chukchi by Funk et al. (2010). It appears that small numbers of harbor porpoise transit through and feed in the Chukchi Sea during summer.

Contact with Oil. Harbor porpoise are present in the Alaska Chukchi Sea during the open water period (Suydam and George, 1992). They may, upon contacting spilled oil, experience inhalation, ingestion, skin and conjunctive tissue irritation similar to bowhead whales, and also may exhibit detection and avoidance of spilled oil.

Contamination and Reduction of Food Sources. The fisheries prey base of harbor porpoise could experience reduction in abundance, distribution and diversity from contact with oil and experience injury from consuming contaminated food items or from direct contact with oil fractions. The fate of nearshore forage fish in the Alaska Arctic, in detection and avoidance of a VLOS, declining or contaminated food sources causing redistribution, injury or mortality, contamination and fluctuations in prey numbers, and recovery of prey post-spill will determine the persistence and use of the LS 193 area and adjacent areas (see Section IV.E.5, Fish Resources).

Displacement from and Avoidance of Habitat. The fate of nearshore forage fish presence and abundance in the Alaska Arctic, in detection and avoidance of a VLOS, declining or contaminated food sources causing redistribution, injury or mortality, contamination and fluctuations in prey numbers, and recovery of prey post-spill will determine the persistence and use of the Sale 193 area and adjacent areas. Harbor porpoise could be excluded from the Chukchi Sea if the forage fish prey base was substantially reduced or eliminated for even a short period of time. It could take many years for porpoises to reestablish the current seasonal use of the Alaska Chukchi Sea even after or if prey populations become restored (see Section IV.E.5, Fish Resources).

Phase 3 – Onshore Contact

Onshore contact (Phase 3) with oil and gas would have no effects on Chukchi Sea or Beaufort Sea cetaceans as the pelagic habitats of these species do not include any onshore resources.

Phase 4 – Oil spill Response, Cleanup, Restoration, and Remediation

Oil spill response, cleanup, restoration, and remediation (Phase 4) has the potential to adversely affect the three ESA listed endangered whales (bowhead, fin and humpback), five unlisted species of cetaceans (gray, minke, beluga, killer whales and harbor porpoise), and their habitats that occur in the sale area. The potential impact producing factors may be the following:

- Noise and disturbance from vessel presence and activity including boom and skimming operations.
- Aircraft overflights, including potential application of dispersants from low flying aircraft.
- In-situ burning, including noise and disturbance from support operations.
- Animal rescue, scientific recovery and disposal of contaminated carcasses.
- Skimmer and boom team composition, number, distribution and noise.
- Relief well drilling and discharges, including support activities such as ice breakers, and vessel discharges.
- Bioremediation activities, including short and long term monitoring and research studies to evaluate effectiveness of cleanup actions, that treat affected areas to neutralize toxic effects or removal and disposal operations to eliminate risk from oil contaminated soil, water, and equipment (booms, cleaning wastes, and sewage from operations, personnel).

Please refer to Section IV.C.1.f(1) of the Sale 193 FEIS (pp. IV-80 through IV-116; USDOI, MMS, 2007a) for detailed discussion of the potential effects of noise and disturbance from most of these oil and gas related activities on endangered whales, and refer to Section IV.C.1.h. (pp. IV-149 through IV-156; USDOI, MMS, 2007a) for potential effects on unlisted species of cetaceans. In most cases noise and disturbance (including collisions) from vessels, aircraft, drilling, and discharges are as described for the effects of these same types of operations associated with exploration, development, and production, including drilling and support activities. In most cases temporary, non-lethal effects would result from contact with a VLOS. In some cases, a cetacean species may require two or more generations coincident with restored and unaffected habitat to restore distribution and populations.

The analysis below is organized by species, with IPFs discussed for each. Thorough discussion of potential impacts to the endangered bowhead whale will often serve to introduce concepts applicable to other species.

Bowhead Whale

Noise and disturbance from vessel presence and activity. Cleanup operations following a large or very large 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 above section on vessel traffic, bowheads react to the approach of vessels at greater distances than they react to most other industrial activities, and vessel and associated cleanup activities may be encountered by bowheads frequently and would likely induce avoidance responses that would cause extra expenditures of energy. 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). Vessels deployed on skimmer/boom teams likely would be less than 75 feet in length (about the size of a fishing vessel) and booming operations would be operating at low speeds. These vessels and smaller vessels produce higher frequency noise that certainly add to the ambient noise levels but may not be in the frequency range for bowhead and other low frequency whales in some cases. Cavitation noise, onboard engine and equipment noise is not likely to propagate noise levels harmful to or causing avoidance response from bowhead whales more than 1 km from the vessel. Therefore, bowheads would likely avoid the vessels at a distance of over 1 km; however, during transit operations at high speeds at night or during low visibility conditions collision or propeller strikes could occur. Larger vessels for a relief well drilling operations create noise levels from propeller cavitation, and onboard engine noise that propagates at levels causing reaction from bowhead whales. Avoidance may be related to the fact that bowheads have been commercially hunted within the lifetimes of some individuals in the population and they continue to be hunted for subsistence use 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 less than 1 km (less than 0.62 mi) away. Received noise levels as low as 84 dB re 1 μPa 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.

If drill vessels engaged in drilling relief wells are attended by icebreakers, as typically is the case during the fall in the Chukchi Sea, the drilling vessel 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) from the icebreakers (Miles, Malme, and Richardson, 1987). 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.

Based on all of the above information, there could potentially be displacement of bowhead whales from a feeding area following a VLOS, and this displacement could last as long as there are spill response and clean-up vessels present and possibly longer. The severity of impacts depends on the value of the feeding area affected. In the event that a high value area is affected and alternate feeding areas of similar value are scarce, adverse effects to nutritional fitness, reproductive capacity, fetal growth rates, and neonatal survivorship could occur.

Noise and disturbance from aircraft. After a VLOS, it is likely that overflights using helicopters and fixed-winged aircraft would track the spill and determine distributions of wildlife that may be at risk from the spill. Most bowheads are unlikely to react noticeably 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 are likely to resume their normal activities within minutes.

Fixed-wing aircraft flying at low altitudes 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. Under the intensive and frequent overflight patterns of large aircraft dispensing chemical dispersants at low level flight altitudes (less than 300 meters), bowheads would likely respond more severely and, depending on the situation, could harass bowheads and haze them in the direction of flight lines for considerable distances.

Based on all of the above information, the conclusion is that there could potentially be harassment of bowheads away from movement corridors and displacement of bowhead whales from feeding areas following a VLOS, and this displacement could last as long as there is a large amount of oil and related clean-up aircraft (especially dispersant application operations) present. Intensive and frequent low elevation overflights associated with spill response and assessment, monitoring, wildlife monitoring, and media operations could potentially harass and displace bowheads within the spill area or between the VLOS and shore based facilities. Hazing of whales away from a hazardous spilled oil slick is possible. This is especially true during the fall migration when large numbers of whales attempt to cross the Chukchi Sea or take advantage of feeding opportunities where there is exposure to hazardous oil (that associated with large amounts of aromatic components, concentrations of prey lying within the spill contaminated surface slick, or where consumption of oil by surface feeding whales is a hazard). Hazing of migrating whales, while stressful, may be justified to prevent whales from intercepting or migrating through extended areas of spilled oil, and to encourage them to detour around hazardous accumulations of oil and continue migration to the west.

In-situ burning. Deployment of burning operations would primarily occur near the localized origination point of the spill and in prioritized nearshore areas. Spill origination site boom and burn operation noise would likely be masked by the noise emanating from the relief drilling effort, which bowhead whales could avoid as is described in the next subsection. There would also be monitors ensuring that marine species would not be in the vicinity of the burning.

Noise and disturbance associated with skimmer and boomer operations. Booming efforts and associated skimmers utilize vessels to conduct operations, and noise effects as described above apply to bowhead whales. Offshore skimmer operations appear to be restricted to the localized area of the spill source and the specific high value nearshore and coastal sites where infrastructure and facilities for crews and equipment are available. Effects on bowhead whales from these operations are likely to be minor because the nearshore operations, noise, and sensitive coastal sites are not important fall migratory habitat to these whales. Effects are expected to be negligible.

Noise and disturbance from drilling a relief well and support activities. Drilling a relief well is a source of noise and disturbance to bowhead whales with essentially the same impacts as the drilling of the exploration well that failed and would require a relief well. Relief well drilling operations are likely to employ drilling vessels (with ice-breaker support vessels, if necessary) and are estimated to operate at a given well site for a period of about 34 days. The greatest potential for bowhead whales to encounter relief well operations would occur during the fall migration when the majority of the population migrates westerly across the Chukchi Sea and the Sale 193 area. Since 2006, satellite tagging studies since 2006 indicate that migrating whales could be migrating across the Chukchi Sea from September to mid December and could encounter drilling throughout the entire migration period.

Some bowheads in the vicinity of drilling operations would be expected to respond to noise from drilling units by adjusting 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 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. Bowhead whales are likely to detour around an operating relief drilling effort and continue their westward migration. These whales may encounter noise from booming, skimming, support vessels and other activities after detouring around a relief drilling operation. Reactions are likely to be localized, temporary and non-lethal. Please refer to the previous sections on noise (in this SEIS) and disturbance from vessel presence and activity, and noise and disturbance from aircraft, as well as Sale 193 FEIS (Section IV.C.1.f[1][d][3] - Effects of Noise from Icebreakers; Section IV.C.1.f[1][d][3] - Effects from Other Vessel Traffic Associated with Seismic Surveys; and Section IV.C.1.f[1][d][3] - Effects from Aircraft Traffic) for detailed discussions of effects from these similar support activities associated with relief well drilling efforts (USDOI, MMS, 2007a).

Drilling a relief well would also result in discharges that could impact bowhead whales; there could be alterations in bowhead habitat as a result of exploration-related localized pollution and habitat destruction. Bottom founded drilling units may cover areas of epibenthic invertebrates used for food by bowhead and gray whales, but would be localized and inconsequential in comparison to the vast foraging habitat available in the Chukchi Sea. Any potential adverse effects on 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 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. 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.

Animal rescue, scientific recovery, rehabilitation, and disposal. Bowhead whale rescue actions are not anticipated; however, rescue efforts for some other species may bring small vessels into the vicinity of bowheads. Negligible effects are anticipated from small vessels as bowheads would likely avoid the activity and larger vessel operations that would serve as facilities from which smaller craft may be operating (see the above section on noise and disturbance from vessel presence and activity). Recovery of stranded, floating, or otherwise dead or severely injured bowheads or other marine species would be on shore (stranded) or not likely to be in the company of other bowheads at sea. Rehabilitation and treatment facilities likely would be on board a ship or land based and not practical for large whales. Disposal of contaminated carcasses (if any), tissues and oil contaminated materials (absorbent pads, protective gear, etc.) would likely be at an authorized disposal site onshore. Negligible effects are anticipated.

Bioremediation and restoration (short and long term). Bowhead whales would experience a wide variety of exposure to aircraft and vessel noise and traffic and effects would be similar to those discussed above under sections for noise and disturbance from vessel presence and activity, and noise and disturbance from aircraft, as well as within the Sale 193 FEIS (Section IV.C.1.f[1][d][3] - Effects of Noise from Icebreakers; Section IV.C.1.f[1][d][3] - Effects from Other Vessel Traffic Associated with Seismic Surveys; and Section IV.C.1.f[1][d][3] - Effects from Aircraft Traffic) (USDOI, MMS 2007). Aircraft and vessel operations would support many short-term efforts during the initial spill response as well as throughout the spill containment and treatments to minimize volume, spread, and environmental consequences. These include a wide variety of surveillance missions, placement of transmitter equipped buoys (to track spill edge in real time), media coverage, monitoring wildlife, dispersant application, treatments to shorelines and waters, as well as various activities associated with spill research, monitoring, and evaluation. The fate of and effects of dispersant application upon productivity, survivorship and contamination of benthic sediments and invertebrates are addressed in Section IV.E.4. Overall it is possible that the use of dispersants, if permitted, could lead to adverse affects through either reduction of food availability, bio-accumulation, or contamination.

Fin Whale

Potential impacts to fin whales during Phase 4 are similar to those described for bowhead whales, except as noted below. Fin whales are low frequency sensitive whales and although thresholds for response to noise may be species specific, the general discussion relative to bowhead whales applies to fin whales.

The summary of information about the current and historic distribution of fin whales indicates that a few individuals or small groups of these species could be exposed to potential noise impacts. Such effects should be temporary and minor.

Humpback Whale

Potential impacts to humpback whales during Phase 4 are similar to those described for bowhead whales, except as noted below. Humpback whales are low frequency sensitive whales and although thresholds for response to noise may be species specific, the general discussion relative to bowhead whales applies to humpback whales.

The summary of information about the current and historic distribution of humpback whales indicates that a few individuals or small groups of these species could be exposed to potential noise impacts. Such effects should be temporary and minor.

Gray Whale

Potential impacts to gray whales during Phase 4 are similar to those described for bowhead whales, except as noted below.

Gray whales feed upon benthic invertebrates that occur on and in the bottom sediments. Exploration drilling muds and cuttings may cover portions of the seafloor and cause localized pollution. However, the effects likely would be negligible, because areas of sea bottom that are impacted would be inconsequential in relation to the available habitat.

Chemical dispersants used to break up surface oil and and disperse it into the water column, some of which may sink and affect benthic organisms preyed upon by gray whales. If their use is permitted, dispersants could potentially affect productivity, survivorship and contamination of benthic sediments and invertebrates (the primary prey for gray whales) as well as pelagic zooplankton near shore and in the Arctic marine and ice environments over the shallow continental shelf in the Chukchi Sea. Adverse impacts to food availability and potential bioaccumulation could occur.

Minke Whale

Potential impacts to minke whales during Phase 4 are similar to those described for bowhead whales.

Beluga Whale

Potential impacts to beluga whales during Phase 4 are similar to those described for bowhead whales, except as noted below. Belugas are high frequency sensitive odonocete whales and are sensitive to high frequency noise produced by industrial activities including icebreakers (Cosens and Dueck, 1993). Avoidance and flight responses have been observed.

Icebreaker cavitation noise modeled by Erbe and Farmer (2000) indicated icebreaker noise was audible over ranges of 35-78 km and zone of behavioral disturbance was only slightly smaller.

Masking of beluga communication signals is predicted at 14-71 km off the Canadian Coast Guard icebreaker Henry Larson.

Beluga whale rescue actions during a VLOS are considered highly improbable by NMFS. In the event that any rescue attempts are possible, they would occur in the lagoons, where contact with oil could occur in nearshore waters close to facilities, equipment, and personnel. Rescue efforts for injured or stranded belugas may bring small vessels into the vicinity of other belugas already stressed from oil contact and watercraft. Further injury or mortality could occur during rescue operations as well as during post rescue treatment and recovery. Recovery of stranded, floating, and otherwise dead or severely injured belugas or other marine species likely would be on shore (stranded) or shallow water and not likely to be in the company of other live belugas at sea. Stranded belugas may be in groups of live animal or with injured and mortalities included. Rehabilitation and treatment facilities likely would be on board a ship or land based and some mortality and injury could occur during transport from rescue site to such facilities. Population level defects are not expected from rescue operations that are likely handling animals already injured and may be predisposed to mortality.

Killer Whale

Potential impacts to killer whales during Phase 4 are similar to those described for bowhead whales.

Harbor Porpoise

Potential impacts to harbor porpoise during Phase 4 are similar to those described for bowhead whales.

Phase 5 - Long Term Recovery

Over the long term, marine mammals including cetaceans would experience continued exposure to aircraft and vessel noise and traffic. Effects would be similar to those discussed in the sections above. Aircraft and vessel operations would be supporting many longer term efforts for monitoring the recovery of resources, fate of oil and/or dispersants in the Arctic environment, and research and monitoring on the effectiveness of various cleanup and restoration practices. It would be speculative at this time to provide an estimate of the numbers, spatial and temporal framework, diversity of or effects of various post-spill research, monitoring, follow-up treatments, or intensity of post-spill activities. BOEMRE acknowledges the need and reality of long term post-spill activities as such events offer the unique opportunity to prevent, mitigate, and restore damaged resources and human values in the future. Research monitoring and studies are subject to scientific research permits issued by NMFS, while industrial monitoring and resource studies are subject to MMPA authorizations issued by NMFS. These MMPA permits and authorizations provide stipulations and best practices to protect cetaceans from adverse effects, as well as enforcement measures. Vessel maneuvers, aircraft elevation limitations, limits to seasonal period of activity, tagging and handling limits, requiring marine mammal observers are some of these. Minimum impacts to individuals and large numbers of animals are the objective of these required actions. Effect to any given species of cetaceans area expected to be minimal, as subsequent determinations of studies and other efforts are to be carried out through MMPA authorizations from NMFS.

Bowhead Whale

Bowhead whales are and have been the subject of numerous research and monitoring efforts by agencies and industry for over three decades. New efforts are likely to continue into the future with or without a VLOS event, which may serve to increase the level of research and monitoring of this species.

Fin Whale

Fin whales have not been subject to directed research or monitoring in the Alaska Arctic OCS and information regarding them has been coincidental to other studies. They have been exposed to noise and disturbance from industry and agency activities and from monitoring and research aircraft and vessel traffic. Fin whales may experience an increase in research and monitoring effort directed at them, as well as increases in post-spill research and monitoring actions. It is reasonable to assume some direct monitoring effort to be directed at post-spill fin whale response to a VLOS event.

Humpback Whale

Humpback whales have not been subject to directed research or monitoring in the Alaska Arctic OCS and information regarding them has been coincidental to other studies. They have been exposed to noise and disturbance of industry and agency activities, monitoring and research aircraft and vessel traffic. Humpback whales may experience an increase in research and monitoring effort directed at them as well as by other potential increases post-spill research and monitoring actions. It is reasonable to assume some direct monitoring effort to be directed at post-spill humpback whale response to a VLOS event.

Gray Whale

Gray whales have been the subject of numerous studies in the 1980 and 1990's in the Bering, Chukchi and Beaufort seas. Since that time they have been subject to BWASP, COMIDA, BOWFEST and industry research and monitoring activities. Aircraft (fixed wing) and vessel traffic are currently and would remain the main impact producing factors upon gray whales. It is reasonable to assume some direct monitoring effort to be directed at post-spill gray whale response to a VLOS event.

Minke Whale

Minke whales have been observed during a variety of projects in the Bering, Chukchi and Beaufort Seas, including agency and industry research and monitoring activities. Aircraft (fixed wing) and vessel traffic are currently and would remain the main impact producing factors upon minke whales.

Beluga Whale

Beluga whales have been the subject of numerous studies in the in the Bering, Chukchi and Beaufort Seas. They have been indirectly affected by other ongoing efforts including BWASP, COMIDA, BOWFEST and industry research and monitoring activities. Aircraft (fixed wing) and vessel traffic are currently and would remain the main impact producing factors upon beluga whales. It is reasonable to expect direct monitoring efforts to be directed at post-spill beluga whales in the Arctic Chukchi Sea as result of a VLOS event.

Killer Whale

Killer whales, being infrequently observed and occurring in low numbers, have been observed in the Chukchi and Beaufort Seas incidental to other studies. They have been indirectly observed as result of BWASP, COMIDA, BOWFEST, other native, agency and industry traditional knowledge and research and monitoring activities. Aircraft (fixed wing) and vessel traffic are currently and would remain the main impact producing factors upon killer whales.

Harbor Porpoise

Harbor porpoise, being infrequently observed and occurring in low numbers, have been observed in the Chukchi and Beaufort Seas incidental to other studies. They have been indirectly observed as a result of BWASP, COMIDA, BOWFEST and other Native, agency, and industry traditional knowledge and research and monitoring activities. Aircraft (fixed wing) and vessel traffic are currently and would remain the main impact producing factors upon killer whales.

Oil Spill Trajectory Analysis

A hypothetical VLOS could contact offshore areas when and where ESA listed and non-ESA listed cetaceans may be present. The location, timing and magnitude of a VLOS and the concurrent seasonal distribution and movement of cetaceans would determine whether or not contact with the oil occurs. The Oil Spill Risk Analysis (OSRA) models oil spill trajectories from 13 launch areas (LAs). The LAs are shown in Figure B-10.

This section describes the results estimated by the OSRA model for a hypothetical VLOS originating within 13 LAs) in the Chukchi Sea Sale 193 Area contacting specific Environmental Resource Areas (ERAs). ERAs noted in this section are spatial representations (polygons) that indicate a geographic area important to one or more cetacean species (USDOI, MMS 2007a, Appendix A, Table A.1-15). For the purpose of this analysis, the hypothetical the initial event for a very large oil spill could occur any time between July 15 and October 31 and represents a “summer spill.” A 60 day contact period for a summer open water season spill considers that a spill could persist on the surface of the water for up to three weeks before it has dissipated. Oil could continue to spill after October 31 and spilled oil could freeze into the newly forming ice, remain encapsulated in ice throughout the winter and be released as the ice warms and thaws in the spring; therefore, continued spillage of oil after October 31 is considered a “winter spill” with a conservative spilled oil contact period of 360 days. To complete a relief well would take between 39 and 74 days. Fresh oil contributed to the marine environment after October 31 would be considered a “winter spill”. The effectiveness of oil spill response activities is not factored into the results of the OSRA model.

The following discussion presents the results estimated by the OSRA model of the hypothetical VLOS contacting ERAs important to cetacean species. The dynamics of oceanographic, climatic, and biotic factors affecting the distribution and abundance of prey, timing of accessibility to habitats, and corridors for movement determine the opportunity for cetaceans and oil to come into contact. There are situations where aggregations of cetaceans of one or more species can contact oil. Trajectory contact with an ERA does not indicate the entire ERA is oiled, only that it is contacted somewhere.

Bowhead Whale

Summer Spill. The OSRA model results, unless otherwise noted, are expressed as percent of spill trajectories contacting within 60 days during summer (Table B-7). The OSRA model estimates that trajectories from LAs 1-13 could contact ERAs important to bowhead whales. The OSRA model estimates <0.5 to 36% of the spill trajectories starting at LA1-LA13 contact a foraging area for aggregations of gray whales and bowheads in some summer-fall periods (ERA 6). A spill originating within LAs 11, 12 and 13 represent the highest percentage of trajectories contacting with 16%, 35% and 36% respectively. These LAs are adjacent to or in the immediate proximity of ERA 6.

ERAs 29-35 and 42 represent the fall migration corridor and periodic fall feeding aggregations for bowheads in September and October. The percentage of trajectories from LA1-LA13 contacting these ERAs during the September-October period are ≤5% with the exception of the Barrow subsistence area (ERA 42) which is a major bowhead feeding aggregation in most years and for some gray whales each year. The OSRA estimates the percentage of trajectories contacting ERA 42 ranges from <0.5 to 12% from LA1-LA13. A spill originating in LAs 8 and 13 have 12% and 10% trajectories contacting ERA 42 respectively. These LAs are immediately adjacent ERA 42.

Fall migration across the U.S. Chukchi Sea is more widespread across ERAs 35, 36 and 56. The OSRA model estimates <0.5 to 60% of the spill trajectories starting at LA1-LA13 contact ERAs 35, 36 and 56. A spill originating in LAs 12 and 13 would have 50 and 60 percent of trajectories, respectively, contacting ERA 35, and percentages of trajectories range between 16% and 22% for spills originating in LAs 6, 7, 8 and 11. All other LAs have percentages less than 15%. The percentage of trajectories contacting ERA 36 from LAs 10 and 11 are 38% and 51% respectively. The percentage of trajectories contacting ERA 56 are 40%, 40%, 56%, and 27% from LAs 6, 7, 12, and 13, respectively. Peripheral ERAs that experience fall migrating bowheads across the U.S. and Russian Chukchi Sea (ERAs 63, 70, 74, 82, and 91) have percentages of trajectories contacting ≤10% for LAs 1–13.

Winter Spill. Winter spills, which include fresh oil entering the marine environment after October 31 can, within 60 days, contact ERAs through which bowhead whales migrating in late fall across the Chukchi Sea during the month of November. Satellite tracking bowheads in 2006 through 2010 (Quakenbush, 2010b) have indicated bowhead movement through ERAs 16, 46, 61,74, 82, 83, and 91 during November however; the OSRA estimates only ERAs 16 and 61 have 3% within 60 days from LA6.

Winter spilled oil trapped under ice in early winter that becomes free of ice in spring could contact ERAs important to spring migrating and calving bowhead whales within 360 days of a winter spill. The Chukchi spring lead systems (ERAs 19-23 and 45) are critical to spring migrating and calving bowhead whales from late March to mid-June. Winter spilled oil that entered the marine environment on or before January 4 (74 days after a spill event October 31) would have been trapped in ice and released over winter and spring. Much of the toxic aromatic hydrocarbon component would have had the winter period to dissipate into the atmosphere through cracks and moving ice and open water of the polynya system through which many bowheads calve and migrate; thereby much of the inhalation hazard is somewhat reduced. From LA1-LA13 the OSRA model estimates range from <0.5-14% within 360 days for ERAs 19-23 and from LAs 4, 9, 10 and 11 are ≥5%. For ERA 22 the percentage of trajectories contacting from LAs 5, 10 and 11 is 6%, 12% and 14% respectively. For ERAs 20 and 21 the percentage of trajectories contacting from LA10 are 8% and 10% respectively. For ERA 45 the percentage of trajectories contacting from LA9 is 7% within 360 days; all other LAs are less than 5%.

The percentage of trajectories contacting ERAs 12 and 24-28 (Beaufort Sea spring polynya system through which bowheads migrate from Late March to late June) within 360 days during winter from LA1-LA13 does not exceed 5%.

Fin Whale

Summer Spill. Fin whales are present only during the open water season and a summer VLOS, occur in very low numbers and appear widely distributed in the U.S. Chukchi Sea with greater abundance occurring in the Russian portions of the Chukchi Sea. The observation and data records regarding fin whales observed in the lease sale area indicate so few occur that habitats have not been identified. The summer spill discussion noted above for bowhead whales may best represent the fin whale habitats contacted by a VLOS emanating in the Chukchi Sea.

Humpback Whale

Summer Spill. Humpback whales, which are only present during the open water season and a summer VLOS, occur in very low numbers and appear to be distributed within 80 miles of the Chukchi Sea Alaska shore. The observation and data records regarding humpback whales observed in the lease sale area and adjacent areas indicate so few occur there that habitats have not been identified. Gray whale percentage of trajectories contacting ERAs are discussed below for a summer VLOS, and may best represent humpback habitat use at this time.

Gray Whale

Summer Spill. Probabilities in the following discussion, unless otherwise noted, are results estimated by the OSRA model expressed as percentage of trajectories contacting within 60 days during summer (Table B-8). Gray whales are primarily present in the Chukchi and Beaufort Seas during the open water season and vulnerable to a summer VLOS. ERAs 6, 35 and 42 represent consistent annual feeding aggregations gray whales and bowhead whales during the summer and fall period (Ljungblad et al., 1988; Clark et al., 2011; COMIDA, 2009). Prey injury, mortality, and long tern exposure of gray whale prey, benthic invertebrates, to contact with oil present emphasis on these ERAs. The OSRA model estimates <0.5 to 36% of the spill trajectories starting at LA1-LA13 contact a foraging area for aggregations of gray whales and bowheads in some summer-fall periods (ERA 6). A spill originating from LAs 11, 12 and 13 represent the highest percentage of trajectories contacting with 16%, 35% and 36 % respectively. The OSRA estimates the percentage of trajectories from LA1-LA13 contacting ERA 35 ranges from <0.5% to 60%. A spill from LAs 5, 6, 7, 8, 11, 12, and 13 within 60 days represents the highest percentage trajectories; 8%, 16%, 20%, 20%, 22%, 60%, and 50%, respectively. The percentage of trajectories from LA1-LA13 contacting ERA 42, ranges from <0.5% to 10% and the highest percentages are 8% and 10% from LAs 8 and 13 respectively. LAs 5, 6, 7, 8, 11, 12, and 13 are adjacent to or in the immediate proximity of ERA 6 having percentage of trajectories contacting ERA 6 of 6%. 8%, 11%, 15%, 16%, 35%, and 36%, respectively. Historically other shallow shoals (ERA 48, Hanna Shoal) have been used by feeding gray whales. Industry observations (Funk et al., 2010 and 2011) indicate summer presence of gray whales in the general areas of current leases east and south of Hanna Shoal in the U.S. Chukchi Sea. A percentage of trajectories contact ERA 6 from all LAs except LA9. Of these, all but two have percentage of trajectories contacting ≥5% and ≤47%. The OSRA estimates the percentage of trajectories contacting from LAs 2, 3, 5, 6, 7, 11, 12 and 13 are 15%, 18%, 17%, 47%, 17%, 20%, 15% and 8%, respectively.

Gray whales that summer in the U.S. and Alaska Chukchi Sea migrate in early summer and fall along the U.S. and Alaska Chukchi coastline. Migrating gray whales could contact spilled oil from a VLOS in ERAs 38, 39, and 40. The OSRA estimates the percentage of trajectories contacting these ERAs vary from <0.5 to 27% with the ≥5% from LAs 5, 9, 10, 11, 12 and 13.

Minke Whale

Summer Spill. Minke whales are present only during the open water season, occur in low numbers and appear widely distributed in the Alaska Chukchi Sea. The observation data regarding minke whales observed in the lease sale area indicate so few occur there that habitats have not been identified. The Chukchi Sea summer spill discussion noted above for bowhead whales may best represent the minke whale use area contact with a VLOS.

Beluga Whale

Summer Spill. Deaths attributable to oil contamination are more likely to occur during periods of natural stress such as during molting, times of food scarcity, birthing/nursing, or disease or parasite infestations. Beluga whales may be more vulnerable to VLOS effects when large numbers of belugas gather in Kasegaluk Lagoon each summer to molt. According to OSRA modeling, the percentage of trajectories contacting Kasegaluk Lagoon (ERA 6) for LA1-LA13 ranges from <0.5 to 32% over a period of 60 days (Appendix B, Table B-7). If a VLOS did contact the shoreline, oil could persist up to more than a decade in the sediments (USDOI, MMS, 2003: Section IV.C.2.a[3][b][2]). The OSRA estimates ERA 40, the Wainwright subsistence area, has 23% and 27% trajectories contacting from LAs 11 and 12 respectively. All other LAs have 8% or less. The percentage of trajectories contacting the Elson Lagoon 2010 beluga aggregation area and Barrow subsistence area north east of Barrow (ERA 42) from LAs 9 and 13 are 10% and 12%, respectively, with the remainder of LAs ranging from < 0.5% to 2%.

Winter Spill. Beluga whales would also be vulnerable to oil contact during the spring migration (April through June) throughout the spring lead system. Direct contact with some spilled oil could occur portions of the spring lead system were contaminated with oil slick. According to OSRA modeling, the percentage of trajectories contacting the spring lead system (ERA’s19-23) from LA10 is 11% and the remainder of the LAs range from <0.5% to 8% within 360 days. The OSRA model estimates the percentage of trajectories contacting ERA 13, the Kivalina Subsistence are <0.5% for all LAs and for ERA 38, the Point Hope subsistence area, are all <2%.

Killer Whale

Summer Spill. Killer whales are present only during the open water season and a summer VLOS, occur in very low numbers and appear widely distributed in the Alaska Chukchi and Beaufort Seas. The observation data regarding killer whales observed in the lease sale area indicate so few occur there that habitats have not been identified. The Chukchi Sea summer spill discussion noted above for bowhead whales may best represent killer whale use areas that could be contacted by a VLOS.

Harbor Porpoise

Summer Spill. Harbor Porpoise are present only during the open water or ice free season, occur in low numbers and appear distributed along the Alaska Chukchi coast and the Arctic lagoons (Elson Lagoon, Kugrua Lagoon) and along the coast between Wainwright and Barrow and (Suydam and George, 1992; Roseneau, 2010)). The observation data regarding harbor porpoise observed in the lease sale area indicate so few occur there that habitats have not been identified. The Chukchi Sea summer spill discussion noted above for Gray whales and beluga whale nearshore ERAs may best represent the harbor porpoise use areas that could be contacted by a VLOS.

Conclusion

Direct contact with spilled oil resulting from a VLOS would have the greatest potential to adversely affect cetacean species when toxic fumes from fresh oil are inhaled at times and places where aggregations of cetaceans may be exposed. Cetaceans likely would avoid oil spill response and cleanup activities, causing displacement from preferred feeding habitats, and could deter from migration paths for the duration of those activities. Presence of oil on and in the water may be avoided by some and not other cetaceans. Cetaceans as a general group would likely experience some loss of seasonal habitat, reduction of prey, and contamination of prey. Consumption of contaminated prey may adversely affect distribution, abundance and health of cetaceans. Human activities brought about by implementation of Oil Spill Response Plans, cleanup and remediation, and post-spill event follow-up treatment and research and monitoring efforts may displace cetaceans. A variety of adverse effects on cetaceans could result from contact with and exposure to a VLOS event ranging from simple avoidance to mortality of large numbers of cetaceans depending on timing, location, cetacean species involved, and circumstances unique to a given spill event.

It may be possible to mitigate some of these potential impacts, or at least reduce the potential for certain impacts to occur, by implementing one of the deferral corridors included in Alternatives III and IV. Selection of Alternative III would implement the 60-mile Corridor I Deferral illustrated in Figure 1. This corridor would reduce the areas of Launch Areas 8, 9, 10, 11, 12, and 13 available for lease. Hypothetical spills from these LAs exhibit comparatively higher potential for impacts to bowhead whales as compared to other LAs. This tendency is due to the proximity of these LAs to the spring and fall bowhead migration routes. Hypothetical spills emanating from LAs 8-13 also have increased potential to contact coastal areas used by gray whales, beluga whales and harbor porpoises. The proposed deferral corridors are of less consequence for species lacking affinity for nearshore areas. Another manner in which the 60-mile corridor could reduce potential impacts is by increasing the minimum distance of a potential spill source from shore. Longer distances between spill source and shore could allow more time for response to mobilize, and allow increased oil weathering before contact with shoreward ERAs.

Alternative IV contemplates a 30-mile deferral area known as the Corridor II Deferral. Corrdidor II could mitigate the potential for impacts to cetaceans in the same manners as Corridor I. The reduction in leasable area and the minimum distance of leases from shore would be less than Alternative III, meaning a smaller chance of mitigation.

More species-specific summary and conclusions are provided below:

Bowhead Whale

Bowhead whales could experience contact with fresh oil during summer and fall feeding event aggregations and migration in the Chukchi Sea and western Beaufort Sea. Skin and eye contact with oil could cause irritation and various skin disorders. Toxic aromatic hydrocarbon vapors are associated with fresh oil. Prolonged inhalation within fresh oil could result in impaired endocrine system function that may result in reduced reproductive function (that may be temporary or permanent) and/or bowhead mortality in situations where prolonged exposure to toxic fumes occurs. The rapid dissipation of toxic fumes into the atmosphere from rapid aging of fresh oil and disturbance from response related noise and activity limits potential exposure of whales to prolonged inhalation of toxic fumes. Exposure of aggregations of bowheads, especially if calves are present could result in multiple mortalities. It would be likely that surface feeding bowheads would ingest surface and near surface oil fractions with their prey, which may or may not be contaminated with oil components. Incidental ingestion of oil factions that may be incorporated into bottom sediments can also occur during near-bottom feeding. Ingestion of oil may result in temporary and permanent damage to bowhead endocrine function and reproductive system function; and if sufficient amounts of oil are ingested mortality of individuals may also occur. Population level effects are not expected; however in a very low probability, high impact circumstance where large numbers of whales experience prolonged exposure to toxic fumes and/or ingest large amounts of oil, injury and mortality is possible to a population level effect.

Exposure to bowheads could occur in the spring lead system during the spring calving and migration period. Exposure to aged winter spill oil (which has had a portion or all of the toxic aromatic compounds dissipated into the atmosphere through the dynamic open water and ice activity in the polynya) presents a much reduced toxic inhalation hazard. Some inhalation, feeding related ingestion of surface and near surface oil fractions may occur during this period and may result in temporary and/or permanent effects on endocrine and reproductive performance. It is possible that a winter spill would result in a situation where toxic aromatic hydrocarbons would be trapped in ice for the winter period and released in toxic amounts in the spring polynya system when bowheads are migrating through in large numbers. In this low probability situation, large numbers of calves could die and recovery from the loss of a large portion of an age class cohort and its contribution to recruitment and species population growth could take decades.

Bowhead whales could be exposed to a multitude of short and longer term additional human activity associated with initial spill response, cleanup and post event human activities that include primarily increased and localized vessel and aircraft traffic associated with reconnaissance, media, research, monitoring, booming and skimming operations, in-situ burning, dispersant application and drilling of a relief well. These activities would be expected to be intense during the spill cleanup operations and expected to continue at reduced levels for potentially decades post event. Specific cetacean protection actions would be employed as the situation requires and would be modified as needed to meet the needs of the response effort. The response contractor would be expected to work with NMFS and state officials on wildlife management activities in the event of a spill. The two aforementioned groups most likely would have a presence at the Incident Command Post to review and approve proposed activities and monitor their impact on cetaceans. As a member of the team, NFMS personnel would be largely responsible for providing critical information affecting response activities to protect cetaceans in the event of a spill.

Bowheads would be expected to avoid vessel supported activities at distances of several kilometers depending on the noise energy produced by vessel sound sources; drill rig; numbers and distribution, size and class of vessels. Migrating whales would be expected to divert up to as much as 20-30 km around relief well drilling operations and up to a few km around vessels engaged in a variety of activities. Temporary and non-lethal effects are likely from the human activities that would be related to VLOS response, cleanup, remediation, and recovery. Displacement away from or diversion away from aggregated prey sources could occur, resulting in important feeding opportunity relative to annual energy and nutrition requirements. Frequent encounters with VLOS activities and lost feeding opportunities could result in reduced body condition, reproductive performance, increased reproductive interval, decreased in vivo and neonatal calf survival, and increased age of sexual maturation in some bowheads. Effects from displacement and avoidance of prey aggregations and feeding opportunities as a result of human activities associated with spill response, clean-up, remeditation and recovery are not expected to result in population level effects.

Fin Whale

A few individual fin whales could experience similar effects as noted for bowheads above if contacted by oil during the ice free period. Fin whale prey (schooling forage fish and zooplankton) could be reduced or contaminated, leading to modified distribution of fin whales and/or ingestion of oil contaminated prey. Temporary and/or permanent injury and non-lethal effects are likely and mortality or population level effects are considered to be unlikely.

Fin whales would likely avoid the noise related to VLOS response, cleanup and post-event human activities similar to that noted for bowhead whales.

Humpback Whale

A few individual humpback whales could experience similar effects as noted for bowheads above if contacted by oil during the ice free period. Humpback whale prey (primarily schooling forage fish) could be reduced and/or contaminated, leading to modified distribution of humpback whales or ingestion of oil contaminated prey. Temporary and/or permanent injury and non-lethal effects are likely and mortality or population level effects are considered unlikely. If prey populations, presence, productivity and distribution are reduced due to VLOS effects, humpback habitat value would be lost unless the humpbacks in the Alaska Chukchi and Beaufort Seas originate from the Western North Pacific stock. In the latter case, mortality may take three generations or more to restore. The few individual humpbacks in the Alaska OCS and nearshore may be exhibiting pioneer behavior and recovery of even a few animals may require similar pioneer behavior from areas of the Bering Sea and southwestern Chukchi where these whales are more abundant.

Humpback whales would likely avoid the noise related to VLOS response, cleanup and post-event human activities similar to that noted for bowhead whales.

Gray Whale

Gray whale aggregations have consistently occurred near shore along the Alaska Chukchi Sea coast from west of Wainwright to northeast of Barrow. This zone would likely be the location of much of the cleanup operations to protect the coastline, lagoons, and river mouths. Avoidance of intense activities could displace gray whales from preferred feeding areas. Oil contamination of benthic sediments and/or mortality of benthic invertebrates that these whales require could result in a recovery period of many years, and result in abandonment of these primary summer feeding areas that provide the majority of the annual nutritional and energy requirement of these whales. Reduction in body condition, and potential mortality from insufficient body energy to complete the long distance migration of this species to and from as far south as Mexico could occur. Reduction or loss of the portion of the Western North Pacific stock of gray whales using the Chukchi Sea would likely take three generations or more to recover. Population level adverse effects from loss or reduction of prey resources nearshore could result in changes in distribution, habitat use, and/or presence in the Chukchi Sea. Loss of food sources could be reflected in individual body condition and mortality during the long stressful migrations this species endures.

Minke Whale

Individual minke whales could experience similar effects as noted for bowheads above if contacted by oil during the ice free period. Minke whale prey could be reduced or contaminated, leading to a modified distribution of minke whales or ingestion of oil contaminated prey. Temporary and/or permanent and non-lethal effects are likely and mortality or population level effects are considered to be unlikely. Changes in distribution of minke whales in the Alaska Chukchi Sea are not likely.

Minke whales would likely avoid the noise related to VLOS response, cleanup, and post-event human activities they may encounter, similar to that noted for bowhead whales.

Beluga Whale

Beluga whales are vulnerable to contact with a VLOS when large aggregations are gathered in the lagoons and nearshore habitats along the Alaska Chukchi Sea coast during molting and nursing. The fate of beluga prey, especially Arctic cod and other Arctic fisheries, would affect seasonal habitat use, determine if toxic amounts of contaminated fish are ingested, or possibly change distribution of these whales until fisheries recovery occurs. Temporary and/or permanent injury and non-lethal effects are likely. Toxic levels of ingestion could alter endocrine system function and reproductive system function and in severe cases result in mortality of individual whales.

Belugas would come into contact with the human activities associated with cleanup operations when near shore, where localized intensive boom and skimming efforts to protect lagoons and other coastal resources occur. Avoidance behavior and stress to belugas (that have also experienced small boat supported subsistence hunting) in coping with concentrated cleanup activities is likely. Once offshore, belugas could experience inhalation of fumes of fresh spilled oil. Prolonged inhalation of toxic fumes or accidental inhalation of surface oil could result in temporary and/or permanent injury or mortality to some individuals. Displacement from or avoidance of important nearshore habitats are anticipated in subsequent years after a spill could redistribute seasonal use of the Chukchi Sea nearshore areas to less optimal molting and nursing areas and potentially reduce population productivity and recruitment. Should cleanup activities occur in or near lagoons or nearshore feeding areas, molting, or birthing habitats, beluga would abandon these areas for as long as spill related activities persisted. Post spill recovery of belugas to pre-spill abundance and habitat use patterns would be dependant upon the recovery periods necessary to restore pre-spill levels of prey populations and the quality of near-shore preferred habitats. Recovery would also depend on the level of human activity in and adjacent to preferred habitats.

Killer Whale

Individual killer whales could experience similar effects as noted for bowheads above if contacted by oil during the ice free period. Killer whale marine mammal prey abundance and distribution could be reduced, or contaminated, leading to modified distribution of killer whales and/or ingestion of oil contaminated prey. Temporary and/or permanent injury and non-lethal effects are likely and mortality or population level effects are considered to be unlikely.

Killer whales would likely avoid the noise related to VLOS response, cleanup and post-event human activities they may encounter, similar to that noted for bowhead whales.

Harbor porpoise

Individual harbor porpoise could experience similar effects as noted for bowheads above if contacted by oil during the ice free period. Harbor porpoise prey could be reduced or contaminated, leading to modified distribution of harbor porpoise or ingestion of oil contaminated prey. Temporary and/or permanent injury and non-lethal effects are likely and mortality or population level effects are considered to be unlikely.

Harbor porpoise would likely avoid the noise related to VLOS response, cleanup, and post-event human activities. The apparent distribution of the porpoises near shore and in the various lagoons where forage fish are abundant puts these animals at risk of frequent contact with spill clean up activities. Such activities are concentrated (to place booms and skim oil) near the mouths of rivers and near lagoons to protect coastline resources. A reduction of coastal fisheries could reduce the capacity of the Chukchi Sea near shore to support harbor porpoise and, consequently, redistribution of porpoises could occur. Ingestion of contaminated fish could reach toxic levels and result in impaired endocrine function, reproductive impairment, or mortality. Reduction or loss of harbor porpoise in this region requires pioneering individuals or the memory of individuals now using the area to "teach" others that the region is available. A substantial reduction in the low numbers that occur in offshore Alaska Chukchi Sea may take greater than three generations to recover due to the remoteness of this part of their range and the pioneering behavior required to recover.

IV.E.8. Polar Bears

Polar bears are listed under the Endangered Species Act (ESA) as threatened throughout their range. Critical habitat is established for this species and consists of barrier islands, sea ice and terrestrial denning habitat (75 FR 76086 [December 7, 2010]). A very large oil spill (VLOS) could affect polar bears and polar bear critical habitat on sea ice, barrier islands or on the coast. Effects could result from direct contact with oil, inhalation or exposure to toxic fumes from the oil (such as polycyclic aromatic hydrocarbons or PAHs), ingestion of oil or contaminated prey, habitat loss or a lack of available prey. Additional effects could occur during clean up. These impacts could include inhalation or exposure to toxic fumes from clean up products, fouling of fur, disturbance at important on ice or terrestrial sites, and continued contamination or loss of prey species or contamination of important coastal or sea ice habitats.

The impacts that occur during each phase of a blowout and subsequent clean up are discussed below. The most direct impacts would occur as a result of Phases 2 and 3, which entail an offshore oil spill and onshore contact.

Phase 1 (Initial Blowout Event)

The initial phase would likely consist of a large explosion of natural gas and a fire. The rig may or may not be disabled or sink at that point. The impact producing factors that might effect polar bears would be the explosion itself (depending upon the size of the explosion) and the smoke and debris resulting from the fire. As drilling would occur during the open water season, polar bears are not likely to be in the area when the explosion occurs. Polar bears are known to swim long distances between shore and sea ice (Schliebe et al., 2008; Gleason and Rode, 2009), but would likely avoid the noise and activity associated with drilling (Anderson and Aars, 2008).

Phase 2 (Offshore Oil Spill)

Polar bears rely on their fur and a subcutaneous layer of fat for insulation and any oiling would cause the fur to lose its insulating ability. Hurst and Oritsland found that polar bear pelts were similar to those of sea otters and fur seals in terms of the loss of insulation once oiled (Hurst and Oritsland, 1982). Once oiled, polar bears could ingest oil while grooming. Exposure to oil or associated fumes could cause respiratory distress and inflammation of mucous membranes and eyes, leading to damage such as abrasions and ulcerations. High levels of exposure would likely result in death. Chronic low levels of exposure may result in long term sub-lethal effects that reduce fitness. Oiling could lead to hypothermia and result in increased energetic costs or death. Polar bears could also ingest oil by eating oiled seals or carcasses, which could lead to impacts to kidney or liver function.

Polar bears rely primarily on ringed and bearded seals as prey in the Chukchi Sea, but they will also take beluga and walrus. Polar bears will scavenge marine mammal carcasses when available, and do not show an aversion to petroleum products. Polar bears have been observed biting cans of snowmobile oil and neoprene bladders of fuel. One polar bear died as the result of eating a car battery, while another died after ingesting ethylene glycol (Geraci and St. Aubin, 1990; Amstrup et al 1989). Polar bears scavenging on oiled seal carcasses could ingest lethal doses of oil. Studies on seal species have indicated that seals intent on feeding will not avoid an area due to oil or oil sheens (Geraci and St. Aubin, 1990). Polar bears may pursue seals in oiled waters. Ringed and Bearded seals have the ability to metabolize small amounts of hydrocarbons so that such tissue damage is temporary unless the exposure is chronic over time (Kooyman, Gentry and McAlister, 1976). Long term or chronic oil ingestion may result in kidney damage, liver damage, or ulcers in the digestive tracts of seals and the polar bears that feed upon them.

Phase 3 (Onshore Contact)

Depending upon the location of the spill site and other factors, BOEMRE has estimated that oil could contact shore within 10 days (see Table 5). Polar bears could come into contact with oil as they move along the coast or barrier islands, or while moving between shore and the ice edge. Regardless of whether contact occurred at sea, on ice or on land, the results to the physical health of the polar bear would be the same as those listed under Phase 2. If polar bears avoid coastal areas that have been fouled by oil, they may be excluded from important resting or denning areas, which may impact fitness or breeding success.

Phase 4 (Spill Response and Cleanup)

Spill response and clean up activities would involve large number of boats of various sizes, skimmers, airplanes and helicopters. In-situ burning and corralling oil with boom material, or booming off sensitive nearshore habitats may occur. Although the U.S. Coast Guard (USCG) has not previously approved the use of dispersants in the Arctic, their use in the event of a VLOS is foreseeable.

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

As the spill response continues, the oil (and thus the response) will become spread out over a larger area. The amount of oil being discharged daily would decrease as the pressure remaining in the well decreases. BOEMRE has estimated that the flow of oil would decrease from a high of 60,000 bbls/day to a little over 20,000 bbls/day over a 74-day uncontrolled well incident. Depending upon the location of the spill site and the time of the spill, BOEMRE estimates that a discontinuous area of 162,200 square kilometers (km2) to 547,600 km2 would be contacted by oil. As the spill continues, clean up efforts would likely focus on the spill site, villages and areas deemed to be critically important to fish or wildlife. If the spill begins late in the open water drilling season (September to October), then the longer that the spill goes on, the more likely it becomes polar bears will encounter oil and/or disturbance from clean up efforts. In recent years, more polar bears have congregated on shore while waiting for the sea ice to form. Large aggregations of bears from the SBS stock now occur near Cross Island and Barter Island, where bears scavenge on whale carcasses. Wrangel Island also has large numbers of bears from the CBS stock. Were oil to contact one of these aggregations of bears, it would constitute a significant impact to the SBS or CBS stock of polar bears.

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

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

Phase 5 (Long Term Recovery)

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

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

Oil Spill Trajectory Analysis

A VLOS could contact offshore or onshore areas where polar bears may be present. The degree of contact with oil would depend upon the location, timing, and magnitude of the spill. The OSRA model divides the 193 lease sale area into 13 launch areas (LAs) to model the spill trajectories from different sources of origin. The LAs are found in Appendix B, Figure B-10. In many instances, the differences between launch areas are less important than the magnitude of the spill given the large area that a VLOS could encompass.

The drilling season in the Chukchi Sea is the open water season, typically between July 15 and October 31. The time period for stopping the spill with a relief well ranges from 39 to 74 days. BOEMRE estimates that spilled oil could remain on the surface of the water for up to 3 weeks. A spill beginning early in the open water season and stopped within 39 days would therefore persist for 60 days. A spill which started late in the open water season or was not stopped for 74 days would likely freeze into the ice and persist over winter, melting out in the spring. BOEMRE, therefore, analyzed a summer spill that persists for 60 days and 360 days, and a winter spill that persists for 360 days.

This section describes the results estimated by the Oil Spill Risk Analysis (OSRA) model of a hypothetical very large oil spill in the Chukchi Sea contacting specific Environmental Resource Areas (ERAs), Land Segments (LSs) or Grouped Land Segments (GLSs) where polar bears may be found. With the exceptions of Cross Island, Barter Island and Wrangel Island, CBS and SBS polar bears are not usually found in large aggregations. Reductions in sea ice may be resulting in more bears coming ashore and in individual bears spending more time on shore during the fall open water season (Schliebe et al, 2007). Both ringed seal distribution and ice conditions affect polar bear densities. Polar bear populations have been observed to increase or decline as seal populations increase or decline (Stirling, 2002). Polar bears hunt ringed seals in spring leads, pack ice, and at their breathing holes. In spring, polar bears preferentially hunt pups in lairs (Stirling and Archibald, 1977). In addition to areas where polar bears concentrate while waiting to den or for the sea ice to freeze (Wrangel Island, Barter Island and Cross Island, and to a lesser extent Kolyuchin Island, and the Pt. Barrow area), this analysis is focused on the Chukchi and Beaufort sea spring lead systems, and on near shore ice in the Beaufort Sea. The estimated percentage of trajectories contacting the Russian, Chukchi or Beaufort Sea coastlines in the event of a very large oils spill have also been analyzed. A VLOS that occurred during the summer open water period or during the fall broken ice period is likely to have the greatest impact on polar bears (Amstrup et al, 2006).

An Environmental Resource Area (ERA) is a polygon that represents a geographic area during a specific time period. The ERA locations are incorporated from USDOI, MMS (2007a) and found in Appendix B, Figures B-2 to B-5. The ERAs are summarized in Appendix A, Tables A.1–13 through A.1–15 of the Lease Sale 193 EIS. The vulnerability of an ERA is based on the seasonal use patterns of polar bears (USDOI, MMS, 2007a, Appendix A, Table A.1–12). LS and GLS are sections of the coastline and are not seasonal. For this analysis, we do not consider the effectiveness of clean up methods. We make the assumption that if oil contacts the coastline, the oil will remain there.

In the Sale 193 FEIS, the OSRA analysis focused on Wrangel Island, Kolyuchin Island, the Russian coastline of the Chukchi Sea and the Barrow area. Since that time, there have been changes in polar bear distribution related to sea ice loss. Polar bear critical habitat has also been established which includes the U. S. Chukchi Sea coastline and offshore barrier islands. Additional ERAs and GLSs from the original EIS that were not used in relation to polar bears at that time are included here to capture this new information about where polar bears may come into contact with oil. Where possible, ERAs have been used with a year round vulnerability (Jan-Dec). In the event that oil was to contact these ERAs in December through February, it would freeze into the ice and snow over winter and remain frozen in the ice until spring. The oil would then melt out of the thawing ice in the spring.

The additional ERAs and GLSs that we have analyzed in this VLOS analysis all occur on the U. S. side of the Chukchi Sea. The full list of ERAs and GLSs analyzed are in Table 16.

Summer Spills (June 1 – October 31)

The following information is summarized from Tables B-7, B-8. B-11, and B-12. A summer spill is defined as a spill taking place during the open water season between June 1 and October 31. The OSRA model estimates that 2% or fewer of the trajectories launched during this time period would contact Wrangel Island or Kolyuchin Island within 60 days or within 360 days. The OSRA model estimates that 4% or fewer of the trajectories would contact any section of the Russian coastline in 60 days with one exception, from LA9 12% of the trajectories would contact some section of the Russian coastline, though not necessarily where polar bears may be. Over 360 days, the percentage of trajectories that would contact some section of the Russian coastline is 6% or fewer, again with the exception of LA9 where the percentage of trajectories contacting the coastline would be 19%.

Table 16. Polar bear habitat areas analyzed in the VLOS OSRA analysis.

ERA or GLS	Geographic Description	Period of Vulnerability	Figure in Appendix B
ERA 2	Pt Barrow, Plover Islands area	May-Oct	B-2
ERA 8	Maguire and Flaxman Islands	May-October	B-4
ERA 11	Wrangel Island with 12 mile buffer	Jan - Dec	B-2
ERA 20	Southern portion of Chukchi spring lead system	April-June	B-3
ERA 21	middle portion of Chukchi spring lead system	April-June	B-3
ERA 22	Northern portion of Chukchi spring lead system	April-June	B-3
ERAs 24-28	Beaufort Sea spring lead system	April-June	B-3
ERAs 29-34	Beaufort Sea nearshore ice	Sept-Oct	B-4
ERA 43	Nuiqsut subsistence area / Cross Island	Aug-Oct	B-5
ERA 44	Kaktovik subsistence area/ Barter Island	Aug-Oct	B-4
ERA 59	Kolyuchin Island	May - Nov	B-2
ERA 69	Harrison Bay / Colville Delta	May-Oct	B-3
ERA 71	Simpson Lagoon, Thetis and Joe's Islands	May - Oct	B-4
ERA 72	Gwyder Bay, Cottle Return Islands and West Dock	May - Oct	B-4
GLS 95	Russian coastline, LSs 1-39	Jan-Dec	B-9
GLS 96	US Chukchi Sea coastline, LSs 40-84	Jan-Dec	B-9
GLS 97	US Beaufort Sea coastline, LSs85-111	Jan-Dec	B-9

On the U. S. side of the Chukchi Sea, results are more variable. The percentage of trajectories contacting the Pt. Barrow/Plover Islands area within 60 days is 2% or less from all launch areas except LA8 (9%) and LA13 (8%). Within 360 days, the percentage of trajectories contacting this area is 2% or fewer from all LAs except LA7 (6%), LA8 (13%) and LA13 (10%). For the Chukchi Sea spring lead system, 3% or fewer of the trajectories would contact the spring lead system within 60 days. Within 360 days, 4% or fewer trajectories will contact the Chukchi Sea spring lead system. The highest percentage of trajectories contacting the spring lead system are from LAs 10, 11 and 12. Fewer than 1% of trajectories from any LA would contact the Beaufort Sea spring lead system within 60 days. Within 360 days fewer than 6% of trajectories would contact any portion of the Beaufort Sea spring lead system. We also analyzed the percentage of trajectories that would contact nearshore sea ice in the Beaufort Sea, 1% or fewer trajectories would contact any portion of the nearshore ice within 60 days, with the exception of spills originating in LA8 (1-5%) and LA13 (0.5-5%). Over 360 days, fewer than 1% of trajectories would contact the sea ice nearshore with the exceptions of spills originating in LA7 or LA8 (2-6%) and LA13 (0.5-6%). Over 60 days, <0.5% of trajectories would reach the Harrison Bay/ Colville Delta area. This rises to 1% for LA8 and LA13 over 360 days.

Over 60 or 360 days, <0.5% of trajectories reach Maguire, Flaxman, Cross, or Barter Islands. Over 60 or 360 days, <0.5% of trajectories reach Simpson Lagoon, Thetis or Joe's Islands, Gwyder Bay, Cottle or Return Islands.

Over 60 days, 1% of trajectories from LA1, LA2, or LA3 reach the U.S. Chukchi Sea coastline; 4-6% from LA4, LA6, LA7, or LA8; 9% from LA5 or LA9; 17-26% from LA10, LA11, LA12 and LA13. Over 360 days, 1-3% of trajectories from LA1, LA2, or LA3 reach the U.S. Chukchi Sea coastline; 6-11% from LA4, LA5, LA6, LA7, LA8 or LA9; 20-31% from LA10, LA11, LA12 and LA13. Over 60 days, fewer than 0.5-1% of trajectories from LAs 1-6 or from LAs 9-12 reach the U.S. Beaufort Sea coastline; 4% from LA7, 14% from LA8; and 15% from LA13. Over 360 days, <0.5-3% of trajectories from LAs 1-6 and LAs and LAs 9-12 reach the U.S. Beaufort Sea coastline; 7% from LA7, 20% from LA8 and 19% from LA13.

Winter Spills (November 1 – May 31)

The following information is summarized from Tables B-16, B-19, and B-20. A winter spill is defined as a spill taking place between November 1 and May 31, in other words, the trajectories would be launched during this time period. For a winter spill, we have only considered the full 360 day period. The OSRA model estimates that 4% or fewer of the trajectories launched during this time period would contact Wrangel Island or Kolyuchin Island within 360 days. The OSRA model estimates that 5% or fewer of the trajectories would contact any section of the Russian coastline in 360 days with the following exceptions: LA1 (6%), LA4 (12%), and LA9 (32%).

For the U. S. side of the Chukchi Sea, 6% or fewer of the trajectories from any LA would contact the Pt. Barrow/ Plover Islands area within 360 days. For the Chukchi Sea spring lead system, fewer than 6% of the trajectories would contact the spring lead system over 360 days with the following exceptions: LA10 (7-10%), LA11 (3-12%), LA12 (1-14%). For the Beaufort Sea spring lead system, fewer than 5% of trajectories from any LA would contact the lead system ERAs. For the Beaufort Sea near shore ice ERAs, fewer than 1% of trajectories would contact these ERAs. For the Harrison Bay/ Colville Delta ERA, <0.5% of trajectories would contact this ERA except from LA8 where 1% of trajectories would contact some part of the Harrison Bay/ Colville Delta ERA. The OSRA model estimates <0.5% of trajectories originating from any LA would contact ERAs 8, 33, 34, 43, 44, 71, or 72.

Over 360 days, fewer than 2% of trajectories would contact any portion of the Russian Chukchi Sea coastline with the following exceptions: LA1 (6%), LA4 (12%), LA9 (32%) and LA10 5%. Over 360 days, fewer than 5% of trajectories would contact any portion of the U. S. Chukchi Sea coastline with the following exceptions: LA4 (8%), LA5 (12%), LA10 (28%), LA11 (21%), LA12 (20%), and LA13 (9%). Over 360 days, fewer than 5% of trajectories would contact any portion of the U. S. Beaufort Sea coastline with the following exceptions: LA7 (6%), LA8 (9%), LA12 (6%), and LA13 (10%).

Conclusion

In the event of a VLOS in this scenario, most of the contact between oil and polar bear habitat would occur on the U.S. side of the Chukchi Sea. The majority of the CBS stock is believed to den and come ashore on the Russian side of the Chukchi Sea, particularly at Wrangel Island. The majority of the SBS stock of polar bears come ashore and den further eastward in the Beaufort Sea. However there is a large area of overlap between the CBS stock and the SBS stock out on the sea ice in the northeastern portion of the Chukchi Sea. Both stocks are believed to be in decline. If a VLOS were to occur and if it resulted in the loss of large numbers of polar bears, particularly adult breeding age females, this would have a significant impact on the SBS and/or CBS stocks of polar bears. Contact with oil on the U.S. side of the Chukchi Sea would be most likely to occur along the U.S. Chukchi Sea coastline or the U.S. Chukchi Sea barrier islands. In the event of a VLOS, key habitats to protect for polar bears would include the barrier islands and shoreline. The largest percentages of trajectories contacting sensitive habitats originate from the launch areas nearest to shore, LAs 9-13 (Appendix B, Figure B-10). Therefore the most protection to resources is afforded by the broadest coastal deferral, Alternative III. This alternative offers the most protection to nearshore resources, spring lead systems and spring polynyas because it decreases the percentage of trajectories that would contact these resource areas. It also affords more time prior to contact for clean up workers to effect as much clean up as is possible before the oil begins to contact nearshore resources.

IV.E.9. Marine and Coastal Birds

A very large oil spill (VLOS) could affect large numbers of marine and coastal birds due to the fact that they spend so much time on the surface of offshore and nearshore waters. Direct contact is the primary way that oil could kill birds in part due to its toxicity to individuals and their prey. The biology and status of marine and coastal birds are described in Section III.B.5 of the 193 EIS, and as further supplemented in this SEIS.

Effects of a VLOS on marine and coastal birds are discussed below for each of the five phases of the hypothetical scenario. The greatest potential for effects on many species of marine and coastal birds occurs during Phase 2 (Offshore Oil). Onshore contact in Phase 3 would primarily affect many shorebird species and affect nearshore habitats. In all cases, long-term recovery is likely, but most species would require more than three generations and access to unaffected/restored habitats for this to occur.

Phase 1 (Initial Event)

At Phase 1, the potential impact producing factors with relevance to marine and coastal birds could include an explosion and fire from a drilling structure. This phase does not include the release of oil (Phase 2). Few birds would be in the immediate vicinity of a drilling structure during an initial event; therefore, few adverse effects on marine and coastal birds are anticipated.

Phase 2 (Offshore Oil)

At Phase 2, direct exposure to oil and gas is the critical impact producing factor affecting marine and coastal birds. 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. Marine and coastal bird deaths due to oil spills arise from exposure from wetting and loss of thermoregulatory ability, loss of buoyancy, or from matted plumage, inability to fly or forage, ingestion and inhalation of vapors (Section IV.C.1.g(3)(g) of USDOI, MMS 2007a). Species are categorized and discussed below according to their level of potential for substantial effects.

Birds with a Higher Potential for Substantial Effects

Seabirds and waterfowl are most vulnerable to oil spills because they spend the majority of their time on the sea surface and often aggregate in dense flocks.

Murres. Murres forage over a wide area of the Chukchi Sea during the breeding season, but are most concentrated near the breeding colonies at Cape Lisburne and Cape Thompson. In the late fall, juveniles and their male parents 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 a hypothetical VLOS contacting nearshore waters at breeding colonies and to adult males and juvenile murres during the pelagic flightless period.

The potential effects of a hypothetical VLOS are greater with murres than most other marine and coastal bird species because a spill could impact discrete colonies, namely those at Cape Lisburne and Cape Thompson. Foraging adults could be killed if contacted by oil and would 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 murres, even if they are not directly exposed to oil. Murres 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 murres could be affected. Hundreds of thousands of murres occur at the Cape Lisburne and Cape Thompson colonies. Oil contacting murres at or near the colonies has the potential to kill a majority of the birds there. Given that murres 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.

Juvenile murres and attendant males are particularly vulnerable while they are flightless and unable to rapidly move out of the area affected by a VLOS in the open sea. The core of the late-season molting area is in an offshore area of the southern Chukchi Sea, north of the Bering Strait. Oil contacting molting murres in this molting area could kill many murres. The adverse population impacts from oil contacting the molting area when juveniles and adult males were present would be somewhat less than those at the breeding colonies, because breeding females would not be in the pelagic molting area; 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. Most post-breeding puffins are located near Cape Lisburne in September.

The tufted puffin is an obligate cliff nester. 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 tufted puffins are long-lived birds with low reproductive rates, effects of a spill could reduce abundance at colonies for several years. All sex and age classes of puffins could be affected. The potential effects of a very large 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. Recovery from mortality associated with the hypothetical VLOS likely would take more than three generations to occur. Abundance at cliff colonies could be reduced for 15 years or longer.

A very large oil spill could also affect widely scattered horned 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. If oil were to move to waters very near these colonies, nesting birds could be contacted and die. Given the distribution of these colonies, population recovery could occur from surrounding colonies once oiled beach habitats are restored, but this could take as long as 15 years depending on the extent of contact.

Short-tailed Shearwaters and Auklets. Short-tailed shearwaters and auklets are considered together, because they occur in similar numbers, and both forage on patchily distributed zooplankton in pelagic waters of the Chukchi Sea.

The non-uniform distribution of these species could favor their survival during an oil spill or lead to extensive mortality. Short-tailed shearwaters number between 20 and 30 million birds in the northern hemisphere and are widespread (but patchily distributed) within the Chukchi Sea. Flocks of shearwaters could number in the tens of thousands and several resting or foraging flocks could be contacted and killed by spilled oil.

Auklets could number over 100,000, depending on seasonal intrusions of Bering Sea water that increases zooplankton availability in the south-central Chukchi Sea. Flocks of auklets could number in the tens of thousands and large foraging flocks could be contacted and killed by spilled oil. As a consequence, as many as 100,000 auklets and/or 100,000 shearwaters could be affected by a VLOS, especially if the spill covered a large area and contacted large groups of birds. 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. This would be an adverse impact to the regional population, but recovery would likely occur in fewer than three generations because these populations are robust and widespread, and nest outside of the Chukchi Sea.

Kittlitz's Murrelet. The Kittlitz's murrelet occurs in relatively limited numbers in the U.S. Chukchi Sea off the North Slope (Day, Gall, and Pritchard, 2011). A large majority of Kittlitz's murrelets in the eastern Chukchi Sea could be killed if oil were to contact them in coastal areas. This species is widespread in low numbers throughout Alaska and birds offshore of the North Slope are at the outer range of the species distribution. Recovery would depend on dispersal from other areas, a time period that could exceed three generations.

Black Guillemot. These birds usually are closely associated with the ice edge. Impacts to black guillemots could be extensive if a spill occurred when the ice edge was in close proximity to the spill location or if nearshore habitats are contacted. 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 once oiled habitats had recovered, which depends on the extent of contact.

Loons. Loons using the Chukchi Sea typically migrate close to shore until they are south of Cape Lisburne, when they travel over pelagic waters on their migration to wintering areas. Loons using nearshore areas could be affected by oil contact in nearshore waters along the coast during the open water season. A hypothetical VLOS could affect nearshore areas used by nonbreeding loons or, later in the open-water season, loon broods. Depending on the spill timing, trajectory analysis, and locations of offshore loons, a large proportion of any sex-age class could experience extensive mortality. Yellow-billed loons in the Chukchi Sea are at particular risk due to their low numbers and low reproductive rate. Extensive mortality of certain sex-age classes could contribute to immediate or gradual population-level impacts, including the large-scale loss of the yellow-billed and other loons on the Arctic Slope.

Spectacled and Steller's Eiders. Spectacled and Steller's eiders must stage offshore in the spring if their breeding habitats are unavailable. Spring leads are open water areas used by spectacled and Steller's eiders during the spring (April – June). The eiders then move to the tundra to nest.

Most post-breeding spectacled and Steller's eiders move to the offshore. Some spectacled eiders stage offshore near Barrow in the Plover Islands. Steller's eiders make little use of this area because their abundance is small and their distribution is limited. Spectacled and Steller's eiders migrate west to the Ledyard Bay Critical Habitat Unit (LBCHU; Figure 1). Critical habitat is a special designation under the Endangered Species Act that represents an area especially important to the persistence and recovery of a listed species. The LBCHU is especially important to spectacled eiders that molt there in dense flocks from July to November. Steller's eiders continue south and west of the LBCHU to different molting areas. Any oil entering the LBCHU has some potential to contact a dense flock of molting spectacled eiders, possibly including the late season aggregation of the North Slope's successful breeding females and their broods. This level of mortality likely could not be recovered within three generations, even if the eider populations otherwise remain stable.

Long-tailed Duck. 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.

Long-tailed ducks could experience extensive mortality if a very large oil spill contacted important duck habitats, including Peard Bay and Kasegaluk Lagoon. As many as 7,000 long-tailed ducks can occur at one time in Peard Bay late in the open-water season. If spilled oil were to enter Peard Bay and contact these birds, the entire flock could be killed. Similarly, as many as 9,000 long-tailed ducks can occur at one time in Kasegaluk Lagoon during the open water season. If spilled oil were to enter Kasegaluk Lagoon and contact these birds, the entire flock could be killed. Recovery of the regional population from mortality of more than 7,000 and/or 9,000 long-tailed ducks would not likely 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. 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 common eiders even if they are not directly exposed to oil. Common eiders also may incur sublethal effects and either die later or fail to breed in future years due to immuno-suppression or reduced fitness. As with other eiders, the common eider probably molts in locations having high-density prey items.

Several hundred common eiders breeding on offshore barrier islands of the Arctic Coastal Plain could experience extensive mortality if contacted in nearshore waters. 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.

Impacts to common eiders could be extensive, especially from oil contacting Kasegaluk Lagoon or Peard Bay. As many as 4,000 common eiders can occur at one time in Peard Bay late in the open-water season. If spilled oil were to enter Peard Bay and contact these birds, the entire flock could be killed. Similarly, as many as 2,000 common eiders can occur at one time in Kasegaluk Lagoon during the open water season. If spilled oil were to enter Kasegaluk Lagoon and contact these birds, the entire flock could be killed. Recovery of the regional population from mortality of more than 2,000 and/or 4,000 common eiders would not likely occur within three generations.

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. King eiders tend to occur farther offshore in greater concentrations of broken ice. 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 are less abundant than common eiders. 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.

Although reduced from population levels of the mid-1970s, the king eider population in the nearby Beaufort Sea remains relatively large and has a positive long-term (14 year) growth rate. Hundreds of king eiders could be killed. 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. Impacts to black-legged kittiwakes 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, in which case a VLOS would be less likely to affect a large proportion of the kittiwakes in the Chukchi Sea. Impacts to kittiwakes at Cape Thompson and Cape Lisburne likely would be similar to other seabirds nesting there. A large proportion of the entire nesting population (~48,000 birds) could be killed if oil were to contact them in nearshore waters around these colonies. It would likely take more than three generations for the regional population to recover from this level of mortality because recolonization by birds from more southern colonies is expected once oiled habitats had recovered.

Pacific Brant. Pacific brant could be affected by an 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. As much as 45% of the estimated Pacific Flyway population can be located in Kasegaluk Lagoon at any one time. Under a hypothetical very large oil spill scenario, a very large oil spill could contact 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. The loss of as much as 45% of the Pacific Flyway population of brant could occur if oil contacted these geese in nearshore waters. Recovery from this level of mortality would take more than three generations to occur.

Phalaropes. Phalaropes are most abundant in the Chukchi Sea during the post-nesting 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 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. A VLOS could contact and kill 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.

Given the high variability in shorebird abundance at migration stopover sites, a VLOS could affect either very few or almost every phalarope using an area, depending on when the spill occurred. Migrating flocks often number in the hundreds of birds. If several flocks were contacted by spilled oil, mortality of at least several hundred phalaropes could occur. Phalarope populations appear stable. 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. If oil from a VLOS were to contact nearshore areas/channels adjacent to the nesting colony, most nesting birds there could be killed. This could eliminate one of two consistently occupied nesting colonies for lesser snow geese in the U.S. The loss of this breeding colony would require more than three generations to recover, increasing the importance and vulnerability of the lesser snow goose population at the remaining U.S. colony near Prudhoe Bay.

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 a very large oil spill.

More than 4,000 greater white-fronted geese have been observed in Kasegaluk Lagoon. A VLOS entering Kasegaluk Lagoon during their period of occupancy could contact and kill them. A VLOS also could lead to ingestion of contaminated food resources or decrease the abundance of those food resources. A relatively small number of nesting tundra swans in Kasegaluk Lagoon could also be contacted and killed.

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 VLOS during periods of peak abundance could contact and kill large numbers of dunlins. Impacts to bar-tailed godwits, given their recent population declines, could be particularly important.

Birds with a Lower Potential for Substantial Effects

The birds discussed below spend less time in direct contact with water and, therefore, the potential for substantial effects is considerably lower than for seabirds and waterfowl above.

Northern Fulmar. Most fulmars are present only in the southern portions of the Chukchi Sea for a few weeks at the end of summer. Spilled oil could contact and kill non-breeding fulmars as they spend most of their time foraging or resting on the sea surface. Given that few fulmars would be present in areas potentially affected by a VLOS, the likelihood of large-scale mortality and other impacts is minimal. Any mortality to the regional population is anticipated to be recovered within three generations.

Gulls and Terns. Ross's gulls and ivory gulls are ice-associated birds and breed well outside the Chukchi Sea. They are present for a short period while migrating through the Chukchi Sea to overwintering locations. Terns migrate through the Chukchi Sea but are rarely observed in pelagic waters. Large-scale mortality or other impacts to these species are less likely than many other species of marine and coastal birds, depending on the season.

Jaegers. Jaegers are present throughout the Chukchi Sea, but are not known to occur in high concentrations. Spilled oil could contact and kill jaegers as they spend most of their time foraging or resting on the sea surface. The likelihood of large-scale mortality and other impacts to jaegers is minimal because they occur in low densities and few would be affected at any particular time or place. Any mortality to the regional population is anticipated to be recovered within three generations.

Raptors. No raptors use open water areas of the Chukchi Sea. There are low numbers of a variety of vagrant raptors that could be attracted to dead or dying birds or floating carcasses that they could carry to shore. Anticipated impacts to raptors from a very large oil spill likely would be minimal, but low numbers of raptors may be killed if they were to feed on oiled carcasses and be affected by the oil themselves.

Phase 3 (Onshore Contact)

Shorebird "hot-spots" are temporary concentration areas, most often associated with large river deltas in the Beaufort Sea. While there are no large river deltas along the Chukchi Sea, these same migrating shorebirds must use coastal areas of the Chukchi Sea as they migrate west to wintering areas out of the Arctic. Large numbers of shorebirds could come into contact with spilled oil along shoreline areas and could be affected during the post-breeding period through oil exposure and subsequent hypothermia if they encounter oil on shorelines. They could also be indirectly affected by eating contaminated prey or through mortality in their invertebrate food sources. Such mortality could have population-level effects, because large numbers of shorebirds could be affected.

Phase 4 (Spill Response and Cleanup)

Spill response activities could disturb and displace marine and coastal birds, which could have net beneficial effects by intentionally or unintentionally moving birds away from oiled areas. This displacement may move birds to unoiled areas, with negligible energetic costs, if these habitats were of similar quality. Marine and coastal birds could be harmed, however, if birds moved to inferior habitats where biological needs could not be met. Several species have specific nesting (e.g., islands, cliffs, low-gradient beaches) or foraging requirements (e.g., lagoons, passes between barrier islands) that could be altered by cleanup efforts. While the marine and coastal birds could physically relocate to other areas, those areas may be unsuitable and delay recovery.

Phase 5 (Long-term Recovery)

Long-term describes an impact producing factor that continues to produce effects in populations for more than 2 years. Many of the effects from direct contact of oil to most offshore and onshore areas have the potential to take more than three generations to recover. Similarly, indirect effects on large numbers of shorebirds, such as those to coastal sediments and invertebrates, could persist for extended periods. As these were previously described under more direct effects for Phases 2 and 3, they are not repeated here.

Oil Spill Trajectory Analysis

Above we have addressed the potential impacts to marine and coastal bird species during each phase of the hypothetical scenario. We now use estimated oil spill trajectories provided by the OSRA model to consider the likelihood of such impacts occurring.

This section describes the results estimated by the OSRA model of a hypothetical VLOS in the Chukchi Sea contacting specific Environmental Resource Areas (ERAs) that are important to marine and coastal birds. An ERA is a hypothetical polygon that represents a geographic area important to one or several bird species or species groups during a discrete amount of time. The ERA locations are incorporated by reference from LS 193 EIS (USDOI, MMS, 2007a) and are shown in Appendix B, Figures B-2–B-5. The ERAs important to marine and coastal birds are summarized in Appendix A, Table A.1-13 of the Sale 193 FEIS. The vulnerability of an ERA is based on the seasonal use patterns of marine and coastal birds using the area (Appendix A, Table A.1-12, USDOI, MMS 2007a).

The following paragraphs present the results (expressed as a percentage of trajectories contacting) estimated by the OSRA model of a hypothetical very large spill contacting habitats that are important to marine and coastal birds. Given the wide variety of bird species that use the U.S. Chukchi Sea 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 some bird species could be contacted by a VLOS. For instance, short-tailed shearwaters and some auklet species occur during the summer throughout the Chukchi Sea area, but the hypothetical VLOS could contact large numbers of these birds or none at all, depending on the location of the spill and location of the birds at the time of the spill.

Summer Spill

Under a hypothetical very large oil spill scenario for summer, the OSRA model estimates that ≥1% of spill trajectories from any individual LA could contact ERAs important to birds within 60 days (Appendix B, Table B-2).

Most post-breeding spectacled and Steller's eiders move offshore and then migrate west to the Ledyard Bay Critical Habitat Unit (LBCHU). The LBCHU (ERA 10) is especially important to spectacled eiders that molt there in dense flocks from July to November. Steller's eiders continue south and west of the LBCHU to different molting areas. The OSRA model estimates that 38% and 22% of trajectories from a hypothetical VLOS originating from LA10 or LA11, respectively, could contact spectacled eiders molting in the LBCHU (ERA 10) during the summer within the 60 and 360 day periods. The OSRA LA and the ERA are in close proximity to or overlap each other.

Many pre- and post-breeding shorebirds and waterfowl stage at Kasegaluk Lagoon, while other bird species breed or molt in or near the lagoon. The highest percentages of trajectories from a hypothetical VLOS that could contact Kasegaluk Lagoon (ERA 1) were 16% and 14% from LAs 11 and 10, respectively, within 60 and 360 days.

Waterfowl and shorebirds use Peard Bay, especially in the ice-free season, to breed, molt, and forage during migration. The highest percentage of trajectories from a hypothetical VLOS contacting Peard Bay (ERA 64) over a period of 60 days were 23% and 15% from LAs 13 and 12, respectively. The highest percentage of trajectories from a hypothetical very large spill contacting Peard Bay (ERA 64) during a 360 day period were 25% and 18% from LAs 13 and 12, respectively.

Environmental Resource Area 15 is adjacent to the murre breeding colonies near Cape Lisburne. This ERA also applies to other seabirds breeding at Cape Lisburne including black-legged kittiwakes, puffins, and much smaller numbers of glaucous gulls and pelagic cormorants. Similar species are located at colonies near Cape Thompson (ERA 14). The highest percentages of trajectories from a hypothetical VLOS contacting ERA 15 were 22% and 19% from LAs 9 and 10, respectively. The highest percentage of trajectories from a VLOS contacting ERA 14 was 16% from LA9 within 60 and 360 days. Spilled oil contacting these ERAs is assumed to contact all birds using these areas during the May-October period.

The OSRA model estimates that 9% and 8% of trajectories from LA8 or LA13, respectively, would contact spectacled eiders and other seabirds staging offshore Barrow in the Plover Islands (ERA 2) within 60 days during summer. Within 360 days the above values increase to 13% and 10%, respectively.

The Chukchi Sea spring lead system (ERAs 19-23) is used by marine and coastal birds as they move east to breeding areas or stage offshore if breeding habitats were unavailable. As the hypothetical VLOS would originate during the open water season (post-July 15), the spring lead system, by definition, would not exist or be available for contact within 60 days following a well control incident. The same situation exists for the Beaufort Sea spring lead system (ERAs 24-34). Within 360 days, however, ≤4% of trajectories from a VLOS are estimated to contact the Chukchi Sea spring lead system and ≤6% are estimated to contact the Beaufort Sea spring lead system.

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 ERA 18. The highest percentage of trajectories from a hypothetical VLOS that could contact ERA 18 were about 42%, 19% and 16% from LAs 9, 10 and 4, respectively, within 60 and 360 days.

Winter Spill

The OSRA model estimates that <16% of trajectories from a VLOS starting at LA1-LA13 could contact habitats (ERAs) that are important to marine and coastal birds (Appendix B, Table B-16). The OSRA model estimates that 16% and 10% of trajectories from a hypothetical VLOS originating from LA10 or LA11, respectively, could contact spectacled eiders molting in the LBCHU (ERA 10) during the winter within 360 days.

Many sea ducks must stage offshore in the spring if their breeding habitats are unavailable. Environmental resource areas 19-23 make up the Chukchi Sea spring lead system (April-June) used by eiders and other sea ducks during spring, and the highest percentages of trajectories from a hypothetical VLOS contacting these ERAs are 14% and 12% from LA12 and LA11, respectively during the winter 360 day assessment period. The percentage of trajectories estimated to contact these ERAs is highest because the launch areas and the ERAs are in close proximity to or overlap each other. A VLOS from the other LAs all are estimated to have percentages of trajectories <10% of contacting the spring lead systems of the Chukchi Sea (ERAs 19-23) and Beaufort Sea (ERAs 24-34).

The OSRA estimates ≤6% of trajectories from a hypothetical VLOS originating in any of the LAs could contact sea ducks staging offshore Barrow in the Plover Islands (ERA 2) for a winter 360 day analysis period. Steller’s eiders make little use of ERA 2.

Kasegaluk Lagoon and Peard Bay are important areas for marine and coastal birds during open water in summer and fall, but if these sites were contacted by oil after November 1, the oil would likely over-winter and there would likely be effects on the habitat and the marine and coastal birds as they return in spring and begin to forage and breed in these areas. Up to 8% of trajectories from a hypothetical VLOS from any of the LAs could contact Peard Bay (ERA 64) or 11% for Kasegaluk Lagoon (ERA 1) within 360 days, during winter.

Trajectories from a hypothetical VLOS during winter, within 360 days had an estimated ≤1% contact with the pelagic murre molting area (ERA 18) from any LA.

Conclusion

A VLOS has the greatest potential for affecting large numbers of birds in part due to its toxicity to individuals and their prey and the amount of time these birds spend on the surface of marine and coastal waters. Under a hypothetical VLOS scenario, marine and coastal birds in key areas or at key times could experience a variety of negative effects from petroleum exposure and habitat loss. Key areas evaluated included:

- Kasegaluk Lagoon
- Ledyard Bay
- Peard Bay
- barrier islands
- the spring open-water lead systems
- Cape Lisburne
- Cape Thompson

All of the areas above provide important nesting, molting, or migration habitat to a variety of seabirds, waterfowl, and shorebirds. The Ledyard Bay Critical Habitat Unit is especially important to spectacled eiders that molt there in dense flocks from July to November.

A VLOS during periods of peak use could affect large numbers of marine and coastal birds, including listed eiders, loons, seabirds, and waterfowl. 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.

A hypothetical VLOS could impact large numbers 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. Large-scale mortality could occur to migrating or molting concentrations of marine and coastal birds, including adult male and juvenile murres in the late summer molting area. Mortality from a hypothetical VLOS could result in population-level effects for most marine and coastal bird species that would take more than three generations to recover.

Large-scale mortality could occur with respect to pelagic distributions of auklets and shearwaters during the open-water period.

As a group, the Launch Areas (specifically LAs 8-13) affected by the deferral corridors contemplated in Alternatives III and IV tend to exhibit higher percentages of spill trajectories contacting sensitive nearshore and coastal habitats along the Chukchi Sea. These alternatives may offer protection to nearshore resources, spring lead systems and spring polynyas by decreasing the percentage of trajectories that would contact these resource areas. In this sense, the most protection to nearshore and coastal birds is afforded by the broadest coastal deferral, Alternative III. Deferrals may also afford more time for spill response and cleanup prior to a spill contacting nearshore resources. These benefits would not be expected to accrue to pelagic species of birds.

IV.E.10. Ice Seals

A VLOS is hypothesized to occur following a series of operational failures in a scenario described in Section IV.D. This analysis of the VLOS scenario is divided into five phases representing the Initial Event (Phase 1), Offshore Oil (Phase 2), Onshore Contact (Phase 3), Spill Response and Clean-up (Phase 4), and Long Term Recovery (Phase 5). The following analysis addresses each phase in sequence. Phases 2 and 3 exhibit the greatest potential for large-scale adverse effects on many species of ice seals. A VLOS would affect bearded, ringed, spotted, and ribbon seals to varying degrees in offshore areas, particularly if ice and therefore appreciable numbers of seals are present. Indirect adverse effects are less likely as ice seals are capable of ridding their bodies of accumulated hydrocarbons via renal and biliary mechanisms, mostly within 7 days (Engelhardt, 1983). Onshore contact is only expected to affect spotted seals in very localized areas, since spotted seals select only a few locations along the Chukchi and Beaufort coasts for haulouts. In all cases, each species is expected to recover from any decline in abundance and/or change in distribution within three generations or less.

Phase 1 (Initial Event)

The initial event is a well-control incident that could include an explosion, fire, sinking of the drill rig, and redistribution of sediment and drilling wastes in the local area. This phase does not include the release of oil to offshore waters (Phase 2), contact with shore (Phase 3) or spill response and cleanup (Phase 4). In the proposed Sale 193 area, ringed, bearded, and spotted seals were the most common seal species observed by marine mammal observers during drilling operations (Brueggeman et al., 1992), seismic surveys (Funk et al., 2010; Blees et al., 2010), marine mammal surveys (Brueggeman, 2010), and shallow hazard surveys (Brueggeman 2009). Ribbon seals were observed least of all, and existing survey data rarely note their presence. Impacts to all species of seals potentially present in the vicinity of the initial event are discussed below, with species-specific differences noted as appropriate.

Explosion. An explosion at the drill site could cause direct impacts (auditory, injury, or death) to any seals in the immediate vicinity. Southall et al. (2007) determined the injury criteria for pinnipeds for aerial single pulsed noise events such as explosions was 149 dB re: 20 μPa (Sound Pressure Level) and 144 dB re: (20 μPa)2-s (Sound Exposure Level). Pulsed noise levels exceeding these thresholds may elicit TTS or PTS in any seals within the noise radius stated above. At least one study has demonstrated that other physiological damages, including permanent organ damage, could occur in seals within close proximity to intense explosions (Hill 1978). Ultimately the amount of pressure and noise produced by an explosion would determine the extent of any danger zones for seals in the area. Such pressure and noise levels are highly variable, depending on a host of factors characterizing an explosion.

Because very few seals are expected to occur in close proximity to exploration drilling in the Chukchi Sea, there should be little or no physiological damage to ice seals in the immediate area. However the risks of inducing TTS and PTS in seals would likely extend beyond 60 m from a drilling unit. Based on density estimates produced by NMFS (Allen and Angliss 2010, 2011; Cameron et al., 2009; Kelly et al., 2010) and marine mammal surveys (Funk et al., 2010; Blees et al., 2010; Brueggeman et al., 1992, 2009, 2010), only a few seals, likely less than five, could reasonably be expected to be affected by a large explosion anywhere in the Lease Area (based on density estimates described in Kelly et al., 2010 and Cameron et al., 2010). Any resulting losses in the local seal populations would not lead to population level effects.

Fire. Fire from an intial exploration drilling unit explosion is very unlikely to affect any seals, as very few are expected to be in the immediate vicinity.

Sinking drill rig. Sinking of a drilling unit would have no adverse effects on any ice seals in the area.

Sediment redistribution. Phase 1 could indirectly affect bearded seals by introducing and redistributing drilling muds and sediments into benthic feeding areas. Sediments and metals released into the ocean would precipitate out of the water column, mostly within a few hundred meters of a drilling rig. The deposition of these additional sediments onto the sea floor would likely bury individuals from some sessile benthic species, killing them (see Section IV.E.4, Lower Trophic Level Organisms). Because marine worms, echinoderms, and molluscs are important in the bearded seal diet (Dehn et al., 2007), bearded seals would be unable to forage on patches of the sea floor that have recently been buried under sediments or may ingest small quantities of contaminants. Blanchard, Nichols, and Parris (2010) found little difference in macrofaunal community structure between historic drill sites and the surrounding environment in the Chukchi Sea indicating such effects would be short-term. While some prey items may die as a result of being buried under sediments and tailings, lowering the locations suitability for benthic feeders such as bearded seals, the site should eventually reach a state similar to that of surrounding areas (Blanchard et al., 2008, 2009). Other species of ice seals whose diets do not depend on benthic species would not likely be affected by sediment redistribution.

Phase 2 (Offshore Oil)

Ice seals would be exposed to hydrocarbons in offshore areas during a hypothetical very large oil spill. Oil in the Chukchi Sea could cause short-term physiological effects to ice seals could affect their prey resources. Additional information about potential impacts to seals is available in Section IV.C.1.h(4) of the Sale 193 FEIS (USDOI, MMS, 2007a).

Contact with Spilled Oil. The vulnerability of individual ice seal species to contacting crude oil is largely a function of their seasonal use of different areas. Some coastal use areas, polynyas, and lead systems are the most likely areas for relatively larger numbers of seals to come in contact with spilled oil. These are all aggregation areas for different species of seals at different times of the year. Differences in ice seal distributions are noted in the subsections below.

Spotted seals are known to aggregate in coastal areas during summer months, mostly in Kasegaluk Lagoon, and the areas between Kotzebue and Wales, Alaska. However they also occur in small numbers in Smith Bay, Peard Bay, Dease Inlet, and the Colville River Delta, Alaska. During the summers and open water season, ringed and bearded seals mostly associate with areas of sea ice, where they occur in their highest numbers. In contrast ribbon seals are mostly found in the pelagic areas away from the coast and areas of sea ice during the open water period. As ice encroaches south in the fall, all of the ice seal species move south in tandem with the ice, eventually occupying the Bering Sea. However many ringed and some bearded seals remain in the Chukchi and Beaufort Seas during the winters by creating breathing holes, or using lead systems and polynyas. During winter and spring ringed seals prefer areas of shorefast ice, while bearded seals utilize lead and polynya areas of fragmented pack ice away from the areas of shorefast ice.

Ice seals have the ability to purge their bodies of hydrocarbons through renal and biliary pathways. Although they can get lesions on their eyes and some internal organs from contacting crude oil, studies have indicated that many of the physiological effects self-correct if the duration of exposure is not too great (Engelhardt, Geraci, and Smith, 1977; Engelhardt,1982, 1983, 1985; Smith and Geraci 1975; Geraci and Smith 1976b, 1976c; St. Aubin 1990). However Spraker et al. (1994) observed lesions in the thalamus of harbor seal brains after they were oiled, possibly explaining motor and behavioral anomalies (Englehardt 1983). Frost and Lowry (1994) observed reproductive complications in harbor seals having been exposed to oil during the Exxon Valdez Oil spill.

While seals may experience short-term physiological impacts from exposure to an oil spill as described in the Sale 193 FEIS, Section IV.C.1.h(4) (USDOI, MMS, 2007a), Engelhardt (1983) states that exposure studies in ringed seals reveals they have a great capability to excrete accumulated hydrocarbons via renal and biliary excretion mechanisms, clearing blood and most other tissues of the residues within 7 days. In harbor seals (*Phoca vitulina*), a related species, an investigation revealed that there were no significant quantities of oil in the tissues (liver, blubber, kidney and skeletal muscles) of harbor seals exposed to the EVOS (Bence and Burns 1995), and the decreasing trend in harbor seal numbers since EVOS (4.6% per year) may have been erroneous since harbor seal populations were declining before the spill (Frost et al., 1999). A further analysis of harbor seal population trends and movements in Prince William Sound suggested harbor seals moved away from some oiled haulouts during the EVOS (Hoover-Miller et al., 2001) and the original estimate of 300+ harbor seal mortalities may have been overstated.

The discontinuous area of a VLOS depends on when the spill occurred, the spill flow rate, and duration. Based on average ice seal densities, the size of the surface slick could contact tens of thousands of seals. As ice seals are able to successfully detect/avoid crude oil or reverse physiological effects, as has been suggested by some experts (Geraci and St. Aubin, 1988), there should be few individuals suffering mortality from a VLOS. It is conceivable, however, that because thousands of ice seals could be contacted, a small proportion of seals contacted by oil could die. Thousands of individual spotted, bearded, and ringed seals ice mortalities could occur during the first years after a VLOS.

Changes in Prey Resources. A potential effect of a VLOS may be the loss of fishes and invertebrates from local populations over an area as was described in Section IV.E.5 and Section IV.E.4, particularly Arctic and saffron cod, arthropods, mollusks, and other invertebrates. Adult ringed, spotted, and ribbon seals mostly rely on fishes for the majority of their diets, although young seals may consume large numbers of arthropods like euphausids and copepods. Bearded seals feed on mollusks, polychaetes and arthropods to a large degree, as a part of their very broad diet. The loss of any of these food sources in an area could have far-reaching effects that may last for multiple years, providing a smaller quantitative and qualitative food base for high level predators such as seals. The consequences of such a loss in the prey base would be reduced productivity in seal populations using an area, or even a short-term loss of ice seals from an area.

However the constituents in crude oil break down over time, and weather, ocean currents, and temperature act to disperse oil slicks. Many, if not most, marine organisms produce very large quantities of offspring that are often dispersed by ocean currents. Consequently the loss of biota from an area exposed to crude oil should be replenished within a 2 years, in light of the high reproductive rates, and mobility of many marine organisms, and the influx of younger organisms via ocean currents. Some prey groups such as molluscs may recover more rapidly than others such as fishes. Any ensuing prey distribution changes may contribute to the loss of several thousand individual spotted, bearded, and ringed seals ice seals that could occur following the first two years of a VLOS.

Phase 3 (Onshore Contact)

The only seal species likely to be affected by spills contacting coastlines would be spotted seals. Bearded, ringed, and ribbon seals spend their lives on or around sea ice and rarely if ever come ashore in coastal areas.

Contact with Oil. The effects of seals contacting crude oil were described in Phase 2, and on page IV-156 of the Sale 193 FEIS (MMS, 2007).

Contamination. The effects of oil contamination on spotted seals are the same as described in Phase 2. However abrasive sediments and sands may scrub oil from the coats of some seals lessening the amount and duration of contamination that individual seals experience. Other individual seals that are oiled may inadvertently pick up debris and some sediments that adhere to the oil on their skins and hair. Nonetheless Lowry et al. (1994) found that oiled seal skins shed their crude oil coating after about 7 days of immersions.

Loss of Access to Habitat. A VLOS that contacts the shoreline would not necessarily affect the foraging success of seals since they feed in the water. However, a spill that contacts the shoreline, and remains spread over large areas of water could adversely affect foraging success for spotted seal species. Such effects might last across season and perhaps a few years.

Phase 4 (Spill Response and Cleanup)

Spill response activities could disturb and displace seals from affected marine and coastal areas. Negative short term impacts from disturbance would be outweighed by beneficial effects from intentionally or unintentionally hazing seals away from oiled areas.

The effects of vessel and aircraft traffic associated with an oil spill response and cleanup may displace seals. Such effects have been observed in numerous ship and air-based surveys in the Chukchi and Beaufort Seas over the years (Blees et al., 2010; Brewer et al., 1993; Brueggeman et al., 1991, 2009, 2010; Funk et al., 2010; Treacy et al., 1996). Some activities such as in-situ burning, animal rescue, the use of skimmers and booms, drilling relief wells, etc. could have additive effects, most likely displacing seals to an even greater degree. Marine mammal observers would be used, but only a few seals should be temporarily frightened from the area. It is also likely any seals exposed to a VLOS will be able to detect the oil, at least through olfaction, and attempt to leave the area on their own. This is particularly true if their prey base is adversely affected quantitatively. The use of dispersants are unlikely to have any immediate direct effects on seals in an area exposed to a VLOS event, however there may be some adverse consequences to using certain types of dispersants which may affect the food web, and the long-term effects of dispersant use may extend beyond the proposal area.

Cleanup activities such as beach cleaning may be performed with a high degree of success using newer technologies such as ionic solutions (Hogshead, Evangelos, Williams et al., 2010; Painter, 2011). However, other activities such as spill cleanup under ice or in areas of broken ice may be more problematic. The effects of these activities on seals could vary, depending upon the presence of seals in an area, and pre-existing stress levels.

Hazing seals from oiled areas could preclude more severe impacts.

Phase 5 (Long-term Recovery)

Long-term is defined as affecting populations for more than 2 years. The possible loss of several thousand spotted, bearded, and ringed seals could continue for 2 years and potential recovery may enter the long-term phase. The recent proposal to list ice seals under the ESA indicates concern that these populations could experience population declines due to the anticipated effects of climate change. For the purposes of this analysis, the described mortality levels may recover within three generations if ice seal populations are capable of maintaining their present populations. If ice seal population trends begin a prolonged downward trend, the losses from a VLOS event may not be recoverable, leading to significant adverse effect to seal populations.

Oil Spill Trajectory Analysis

A VLOS could contact offshore and nearshore areas where seals may be present. The probability of contact depends on the location, timing, and magnitude of the spill. The OSRA model uses 13 launch areas (LAs) to model the origin of spill trajectories. The LAs are found in Appendix B, Figure B-10).

The drilling season is typically July 15 through October 31 in the Chukchi Sea. This time period is typically when any spills from drilling would occur. The lack of sea ice during this period permits the safe operation of offshore drilling platforms. In the unlikely event of a well blowout, BOEMRE has determined from 39 to 74 days would be required for another drill vessel to transit to the site and drill a relief well.

Within 60 days for a summer spill the estimated discontinuous area contacted is between 245,800 and 364,100 km2 and within 360 days 264,500 to 450,400 km2 (Appendix B, Table B-5). Winter spills are more restricted in area with 60-day spills covering a discontinuous area contacted of 162,200 to 385,600 km2, and within 360 days 368,400 to 507,200 km2 (Appendix B, Table B-6). Such patchiness in a long duration spill may allow some seals to at least partially avoid or reduce contact with the oil slick, reducing the overall effects on some individuals.

A very large oil spill continuing after October 31 is treated as a winter spill. Since the hypothetical oil spill could continue after October 31 and/or melt out of ice during the following spring, potential trajectories are also assessed over an assessment period of 360 days.

In the event of a VLOS not all of the hydrocarbons are discharged at once, as often occurs with marine accidents such as the Exxon Valdez oil spill in Prince William Sound, Alaska. Instead they flow into the ocean at rates that decrease over time. For the briefest spill period, BOEMRE estimates that a spill could persist on the surface of the water for up to three weeks, therefore a 60 day period of potential contact was analyzed. However, if a spill were to occur late in the open water season, the liquid hydrocarbons may freeze into the sea ice, and could remain overwinter without any extensive amount of weathering. If this were to happen, quantities of unweathered oil could end up being transported to different areas in the Chukchi and Beaufort Seas and be released in the spring. To address concerns such as this, BOEMRE has also analyzed a spill window of 360 days.

This section describes the results estimated by the OSRA model of a hypothetical very large oil spill in the Chukchi Sea contacting specific Environmental Resource Areas (ERAs) that are important to ice seals. An ERA noted in this section is a polygon used to represent an area important to one or more seal species at some stage in their life cycle. During winter bearded and ringed seals are the only species expected to be present in the area and their primary winter habitats include polynyas, lead systems, and shorefast or pack ice for ringed or bearded seals respectively. During the summer (open-water) season ringed, ribbon, and bearded seals may be found swimming in open water, though their numbers increase with proximity to areas of sea ice. Spotted seals are seasonal visitors to the Beaufort and Chukchi seas, and mostly occupy nearshore areas, bays, and lagoon systems where they periodically haul out, sometimes in large numbers. As stated earlier, ribbon seals are mostly pelagic, and tend to occupy the southern and western Chukchi Sea to a higher degree than the proposal areas. With the exception of hauled out spotted seals, other ice seals do not tend to be gregarious for social reasons as much as to exploit limited resources such as available polynyas and lead systems.

ERAs indicating lead systems and major concentrations are incorporated by reference from Sale 193 FEIS and shown in Appendix B, Figures B-2 to B-5, while polynya systems are depicted in Figure III.A-14 of the Sale 193 FEIS. The likelihood of any species being affected by a very large oil spill will be determined by a number of factors including: seasonality occurrence of a species; spill avoidance abilities of a species; presence; distribution; habitat use; diet; timing of a spill; spill constituents; spill magnitude; spill duration; and a species' ability to persist in a contaminated area. Bearded and ringed seals occur in the Chukchi and Beaufort Seas year-round, although a very large proportion of their populations winter south in the Bering Sea ice areas. In contrast, ribbon seals mostly summer in the northern Bering Sea and in the southern Chukchi Sea, where little ice persists during the open water season. Many spotted seals winter in the Bering Sea, however large aggregations (100's and 1000's) may be found in Kasegaluk lagoon, Avak Inlet, and between

Kotzebue and Wales on the Seward Peninsula coast, while lower concentrations (10's) occur in Admiralty, Smith, Kugrua and Peard Bays; and the Colville River Delta.

The following paragraphs present the results (expressed as a percentage of trajectories contacting) estimated by the OSRA model of a hypothetical very large spill contacting habitats that are important to seal species. For example, a very large winter spill from any launch area could hardly be expected to directly affect spotted seals within 60 days since they migrate south in late October-November. However, they could come into contact with spilled oil by June or July of the following year because it would be within 360 days of the spill date. By that time, most of the hazardous components of a spill will have weathered away. Thus, the timing of a spill most likely to affect spotted seals would be one that occurred during the early to mid summer, using the 60 day trajectory.

The OSRA model estimates spill trajectories originating from any individual LA which may have a ≥1% probability of contacting ERAs or Land Segments (LS) with importance to seals within 60 days (Tables B-7, B-9, B-15 and B-18), and 360 days (Tables B-8, B-10, B-16, and B-19). Due to differences in summer habitat use between the different seal species in the analysis area, bearded, ringed, ribbon, and spotted seals will be analyzed independently. Because ice seals may be present in affected areas year-round, this analysis considers the 60 and 360 day time periods for trajectories during summer and winter, unless otherwise noted. To focus on significant impacts (or elevated potential for significant impacts), only a percentage of trajectories contacting ≥5% are discussed.

Bearded Seals

Bearded seal presence during the open water season is correlated with the presence of sea ice. Consequently, they are less common in the southern Chukchi Sea and around coastal areas during the summer period, yet more common near the ice front and in areas of drifting sea ice, particularly in the northern portion of the analysis area. Since they forage for benthic species, bearded seals must associate with relatively shallow waters over the continental shelf. For this reason, bearded seal densities tend to be higher in the sourthern Chukchi Sea early in the spring, and decrease as the open water season progresses. Though the Chukchi Sea has a large continental shelf area, the shelf in the Beaufort Sea tends to be narrow and ultimately the water depths suitable for prolonged bearded seal occupancy may determine the presence and densitites of bearded seals. Consequently, in some years bearded seals in the Beaufort Sea may forage farther from the ice front than those in the Chukchi Sea. The sub-population of resident bearded seals in the Beaufort Sea is estimated at around 3,150 as compared to the estimated 27,000 residing year-round in the Chukchi Sea (Cameron et al., 2009), though both resident populations are considered to be part of the Beringian Distinct Population Segment (DPS) of bearded seals.

Land Segments were not analyzed for bearded seals because this species is strongly associated with sea ice and generally are not found on the shoreline. During winter months their presence is strongly linked to polynyas, areas of broken ice, and lead systems where they have immediate access to water and food resources. During the summer bearded seals do not tend to aggregate, spending much of their time foraging at sea. Throughout the year bearded seals avoid nearshore areas including areas of shorefast ice.

Summer within 60 Days. Higher densities of bearded seals occur in open water near areas of sea ice, and spills are most likely to affect them anywhere in the open water. However, the shallow waters of shoals make them particularly productive from the perspective of a benthos-feeding bearded seal. Consequently, one may expect somewhat larger densities of bearded seals in the vicinity of Hanna (ERA 56) and Herald shoals. LA's 2, 3, 6, 7, 8, 11, 12, or 13 had 14, 22, 40, 40, 15, 19, 56, or 27 percent of trajectories (respectively) contacting ERA 56 in the vicinity of Hanna Shoal (Appendix B, B-1). However, any spills in the open water could very likely affect some bearded seals since they are somewhat ubiquitous in the Chukchi Sea and to a much lesser degree the Beaufort Sea.

Summer within 360 Days. If a VLOS were to occur, freeze into the ice and melt out up to 360 days from the release date, the OSRA model estimates that the Herald Shoal polynya has a 7, 22, 10, or 6 percent of trajectories contacting LA's 1, 4, 5, or 10. LAs 1, 2, 3, 5, 6, 7, 8, 11, 12, or 13 would respectively have 10, 23, 50, 10, 29, 34, 23, 12, 21, or 19% of trajectories contacting Hanna Shoal. LA's 7 or 8 also have 6 or 5% of their respective trajectories contacting Beaufort Lead System 7, although <5% of trajectories contact the remaining spring lead systems.

Winter within 60 Days. The OSRA model estimates 7 or 8% of trajectories from LA10 contact ERA 20 or 21, respectively. Likewise, 5 or 9% of trajectories from LA10 contact ERA's 21 or 22, and 10% of trajectories from LA12 contact ERA 22. All of these ERAs plus ERAs 19 and 23 constitute the Chukchi Spring Lead System where many bearded seals will aggregate during the winter season. Similarly the Herald Shoal polynya system had 8 and 18% trajectories contacting from LAs 1 and 4. The Hanna Shoal polynya has 10, 26, 64, 6, 21, 43, 45, 25, 11, 22, 19, or 25 percent of trajectories from LAs 1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, or 13, respectively. These lead and polynya systems are the only known locations where bearded seals concentrate during winter and any spill that occurs in one of these areas could have marked effects on any seals using them. Such effects may be much higher than what would be expected in open water or during the summer. However, if a spill made its way into a lead or polynya system, any remaining volatile compounds would begin weathering out of the slick, albeit at a slower rate than would occur during a summer spill. The oil weathering models estimates that approximately 30% of oil from a slick would remain from a 60,000 bbl per day summer spill after 30 days, and 48% would remain from a winter (meltout) spill after 30 days (Appendix B, Tables B-3 and B-4). Consequently, at least half of the oil in any of the leads or polynyas would quickly weathered out of the slick and the ensuing effects on bearded seals might be moderated to one degree or another.

Winter within 360 Days. The OSRA model estimates, the Hanna Shoal polynya has 15, 33, 68, 10,29, 51, 54, 38, 19, 33, 33, or 38% of trajectories contacting from LAs 1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, or 13 respectively. The Herald Shoal polynya system would have an 8 or 19 percent of trajectories contact from LAs 1 or 4, while ERA 45.

Ringed Seals

As with bearded seals, ringed seals have a strong association with sea ice. However, unlike bearded seals, ringed seals overwinter in areas of shorefast ice, particularly where heaves and irregularities create icy hummocks that can protect their lairs from polar bear predation. During summer, ringed seals associate with sea ice in the open waters and so may occur in the open ocean where they forage on fishes. It is assumed that their presence and densities in any given area will depend upon the food stocks in a local area, as well as the presence or absence of sea ice. Consequently LSs are not analyzed for ringed seals for a 60 day summer spill. Polynya and lead systems will be analyzed for the 360 day summer, 60 day winter, or 360 day winter time periods.

Summer within 60 Days. The 60 day summer VLOS analysis for ringed seals is the same as what was analyzed for bearded seals. Please consult summer 60-day analysis for bearded seals for greater detail.

Summer within 360 Days. Ringed seals prefer areas of shorefast ice, mostly foregoing areas of pack ice. However they frequently use polynyas surrounded by stable pack ice, such as occurs at Hanna and Herald Shoals during the winter. The spring lead systems in the Beaufort and Chukchi Seas are also important to ringed seals since it allows them to forage for fishes and comfortably rest on an icy platform if needed. The percent of spill trajectories contacting ringed seals in Hanna and Herald Shoals and around any existing lead systems are the same as what was described for bearded seals using the same habitat.

Winter within 60 Day. The percentage of trajectories contacting ringed seal habitat within 60 days are the same as those for bearded seals with an exception. The preferred habitat of overwintering ringed seals is shorefast ice where they can maintain breathing holes, subnivean dens, and whelp on a stable medium. Consequently, the vast majority of ringed seals will not be in any of the LAs or in the open ocean during winter. Instead, they will be in the nearshore zone. Using the grouped land segments for the Beaufort and Chukchi coastlines, the percentage of trajectories contacting the Siberian coast is 8% from LA9. For the United States Chukchi Sea coast the percentage of trajectories contacting are 17, 9, or 7% for LAs 10, 11, or 12 (Appendix B, Table B-19). The OSRA model estimates <5% of the trajectories from any of the LAs would contact the Beaufort Sea coast.

Winter within 360 Day. A winter VLOS within 360 days would have the same percentages of trajectories contacting polynyas and lead systems for ringed seals as it did for bearded seals. Considering the winter habitat use of ringed seals, there is a 6, 12, 32, or 5% of trajectories contacting the Russian Chukchi coast from LAs 1, 4, 9, or 10 respectively. The OSRA model estimates 8, 12, 5, 28, 21, 20, or 9 % of trajectories from LAs 4, 5, 6, 10, 11, 12, or 13 would contact the United States Chukchi Sea coast, and 6, 9, 6, or 10 percent of trajectories contact the United States Beaufort from LA7, 8, 12, or 13 (Appendix B, B-20).

Ribbon Seals

During the summer, ribbon seals have been observed in very, very low numbers during Chukchi Sea marine mammal surveys (Funk et al., 2010; Blees et al., 2010; Brueggeman et al., 1991, 2009, 2010). Ribbon seals spend most of their lives in the open ocean, only relying on the ice front during early spring to briefly whelp, and molt before returning to the water for the remainder of the year. In the Chukchi Sea most ribbon seals are found in the southern and western regions, sometimes being observed in the eastern and east-central Chukchi Sea. Occasionally, a ribbon seal is observed in the vicinity of Barrow, Alaska, although these sightings are believed to be quite rare. Whelping chiefly occurs in the Bering, and perhaps in a few areas of the southern Chukchi Sea. Consequently, they would not be at risk from the proposed action. Any ribbon seals that could be affected by a VLOS would be in the open water and in extremely low densities, and they are not known to associate with any particular ERAs or LSs. At most, no more than a few tens to several hundred ribbon seals could be affected by a hydrocarbon release from any of the LAs in the proposal area. If a VLOS were to occur, BOEMRE expects a fraction of the ribbon seals would be killed, while the remainder would probably recover within a few days. Such numbers would not affect the persistence of a local population or the regional stock of ribbon seals, though recovery might last from 1 to 3 years depending upon the number of individuals lost from the population.

Spotted Seals

Spotted seals are summer visitors to the Chukchi Sea and to a much lesser extent, the Beaufort Sea. Their primary haulout sites in the Chukchi Sea include Kasegaluk Lagoon, and the areas around Kotzebue Sound. Haulout sites in the Beaufort Sea are very small by comparison, hosting populations numbering into the 10's. The known Beaufort haulouts include Dease Inlet/Admiralty Bay, Smith Bay, and the eastern edge of the Colville River Delta. In the following analyses the appropriate ERAs and are analyzed to estimate the percentage of trajectories contacting spotted seal habitat in the proposal area. During the Arctic summer spotted seals are not as strongly associated with ice as are bearded and ringed seals.

As with bearded, ringed, and ribbon seals, any VLOS in open water conditions is likely to contact some individual spotted seals; however, slicks would weather and disperse over time. The VLOS analyzed in the OSRA could be expected to contact hundreds or perhaps even a few thousand spotted seals in the Chukchi Sea, or some 10's of seals in the Beaufort Sea. The largest aggregation of spotted seals that could be oiled occurs in Kasegaluk Lagoon between Icy Cape and Wainwright, where a few thousand seals haul out during the summer.

Summer within 60 Days. The percentage of trajectories contacting spotted seals in the open water are similar to what was described for bearded, ringed, and ribbon seals, however coastal areas are more vulnerable for spotted seals since they are the only ice seal species in the Chukchi and Beaufort Seas that regularly use shore-based haulouts. Kasegaluk Lagoon has a 14, 16, or 5 percent of trajectories contacting from LAs 10, 11, or 12 respectively. All other known haulout sites have <5% of trajectories contacting from any of the LAs.

Summer within 360 Days. As with the summer 60-day time period, a 360-day time period would have a 14, 16, or 5 percent of trajectories contacting Kasegaluk Lagoon. However, there would also be a 6, 13, 12, 18, or 25 percent of trajectories contacting Peard Bay from LAs 6, 7, 8, 12, or 13, and a 5 percent of trajectories contacting Kugrua Bay from LA12.

Winter within 360 Days. The OSRA estimates LAs 4, 5, 10, or 11 have a 5, 6, 11, or 8 percent of trajectories contacting Kasegaluk Lagoon (Appendix B, Table B-16). All other LAs have <5% trajectories contacting spotted seal haulout areas and are not discussed further.

Conclusion

In the event of a VLOS, ice seals could be adversely affected to varying degrees depending on habitat use, densities, season, and various spill characteristics.

Spotted seals are the only phocid species in the analysis area that habitually use shore-based haulouts. Their principle haulout locations that could be affected by a VLOS, ranked from largest to smallest, are Kasegaluk Lagoon, Kugrua Bay, Dease Inlet/Admiralty Bay, Smith Bay, and the Colville River Delta. Kasegaluk Lagoon is the largest haulout location that could be affected, and is several times larger than all of the others combined. Although spotted seals may forage for fishes in the open ocean, their presence is not known to be associated with the ice front. Consequently, their presence is associated with haulout areas and nearshore areas with open water.

In contrast, ribbon seals are the most pelagic seal species in the area, remaining in the open ocean for most of the year except for spring whelping and molting in the Bering and southern Chukchi Seas. Based on their very low presence in marine mammal surveys, BOEMRE concludes that they occur only in very low numbers spread across the Chukchi Sea and are virtually absent from the Beaufort Sea. Consequently, ribbon seal populations are not expected to be affected by a VLOS from any of the OSRA Launch Areas.

Both bearded and ringed seals closely associate with sea ice throughout the year, very rarely, if ever, coming ashore. Both species prefer to forage in proximity to the southern ice edge during the summer months, although some may be found in the open ocean away from areas of sea ice. Bearded seals feed on benthic organisms on the relatively shallow Chukchi continental shelf, while ringed seals forage for fishes and some invertebrates in the water column. These differences in food selection and foraging behavior help determine the presence or absence of each of these species in an area. Bearded seals are essentially restricted to areas over the continental shelf and the ice front where they can reach the seafloor to feed on benthic organisms. Ringed seals may be found under areas of solid ice as well as in the ice front where they predate fishes such as Arctic and saffron cod.

Presently there are no areas identified as important ringed, bearded, or ribbon seal habitat during the summer months. However, during the winter, conditions change drastically with the southward advance of sea ice, when only bearded and ringed seals persist in the Chukchi and Beaufort Seas. During winter, bearded seals loosely congregate around polynyas, and lead systems, generally avoiding areas of shorefast ice. Ringed seals, however, select shorefast ice zones as their primary habitat where they survive by making and maintaining breathing holes through the ice and by constructing subnivean lairs, particularly under pressure ridges where they are somewhat protected from predators. If lead systems or polynyas occur near the shorefast zone, ringed seals may often maintain a presence in proximity to the lead or polynya. However, because of their site fidelity and need for stable ice, they are strongly linked with stable shorefast ice. Any VLOS reaching a polynya or lead system could therefore have serious effects on local ringed and bearded seal sub-populations, potentially oiling or even killing hundreds to thousands of bearded and/or ringed seals.

Potential effects of a VLOS event on fishes and invertebrates are analyzed in greater detail in other resource sections (Sections IV.E.4 and IV.E.5). Because ice seals rely on these organisms for food, any significant impacts on fishes or invertebrates would have serious consequences to seal populations. A massive die off of prey species would most likely cause seals to leave the area to seek food elsewhere. While such movements would entail some energetic cost, it is unlikely many seals would immediately starve to death. However displaced seals would compete with seals elsewhere for the limited food resources, perhaps lowering the overall fitness of a local population, or even contributing to the loss of population segments through malnutrition. Consequently a VLOS has the potential to affect large numbers of seals in part due to the effects their prey and the local food-web. Mortality from a hypothetical VLOS could result in temporary population-level effects for bearded, ringed, and spotted seals, and to a much lesser degree ribbon seals due to their scarcity in the analysis area.

If Alternative IV is selected, portions of LA8–LA13 would be deferred, and if Alternative III is selected larger portions of LA8–LA13 would not be available for oil and gas exploration and development under Sale 193. As these LAs generally exhibit a higher percentage of trajectories contacing nearshore areas, deferring portions of these areas can reduce the potential for impacts on coastal habitats and the species that use them, like spotted seals. Depending on the season, Alternative III or IV could also reduce percentages of trajectories contacting areas important to bearded and ringed seals, such as Hannah Shoal, polynyas and spring lead systems, and (in the case of ringed seals) shorefast ice. The larger deferral associated with Alternative III has greater potential to reduce nearshore impacts as compared with Alternative IV. It is more difficult to correlate any benefits to ribbon seals from either deferral corridor.

IV.E.11. Pacific Walrus

A very large oil spill (VLOS) could affect Pacific walrus at sea, on sea ice, or at coastal haulouts. Effects could result from direct contact with oil, inhalation or exposure to toxic fumes from the oil (such as polycyclic aromatic hydrocarbons or PAHs), ingestion of oil or contaminated prey, habitat loss, or prey loss. Additional effects could occur during clean up and well control work. These impacts could include inhalation or exposure to toxic fumes from clean up products, disturbance at important on ice or terrestrial haulout sites, and destruction of prey species.

The impacts that occur during each phase of a blowout and subsequent clean up are discussed below. The most direct impacts would occur as a result of Phases 2 and 3, the oil spilled offshore and onshore. The most recent estimate of the Pacific walrus population suggests a minimum of 129,000 walrus (Speckman et al, 2011). Some researchers believe that the population may be in decline based on age structure and productivity information (GarlichMiller, Quakenbush and Bromaghin, 2006). The Pacific walrus is listed as a candidate for threatened status under the Endangered Species Act due to the continuing loss of sea ice habitat caused by climate change (76 FR 7634 [Feb 10, 2011]). With a population in decline, any loss of large numbers of walruses, walrus habitat, or prey species would exacerbate that decline. Recovery would not occur unless the population begins to rebound from other factors that may be limiting population productivity or growth.

Phase 1 (Initial Event)

The initial phase could include a large explosion of natural gas and a fire. The rig may or may not be disabled or sink at that point. The impact producing factors that might effect walrus would be the explosion itself (depending upon the size of the explosion and their proximity to it) and the smoke and debris resulting from the fire. Walrus are very sensitive to disturbance and are unlikely to remain in the vicinity of an active drilling operation, especially during the open water season when ice is not present. If walrus were in close enough proximity to be able to hear the explosion, they may experience TTS or PTS depending upon their proximity and the sound level of the explosion, and they may also be frightened into a panic and leave the area. During stampedes from coastal or ice floe haulouts, calves and smaller walrus are the most vulnerable to injury. Falling ash and debris could also haze walrus away from the area. If the explosion occurs at the sea floor, benthic invertebrates may be destroyed in the area affected by the explosion or the sunken platform. This area would then be unavailable as a feeding area for walrus until it is recolonized by invertebrate species, which could then lead to displacement.

Phase 2 (Offshore Oil Spill)

Walrus could be directly and indirectly affected by an offshore oil spill. Exposure to oil or associated fumes could cause respiratory distress and inflammation of mucous membranes and eyes, leading to damage such as abrasions and ulcerations. Walrus, which have large protruding eyes, would be particularly vulnerable. Walrus rely primarily on a thick layer of blubber for insulation and therefore are less likely than fur bearers to suffer from hypothermia as a result of oiling. However, they may be more likely to suffer skin inflammation and ulcers as a result of oil exposure. Studies have shown that while marine mammals such as walrus are not usually killed by surface contact with oil, ingestion of oil or oil contaminated prey items can cause tissue changes (Kooyman, Gentry and McAlister, 1976). Ringed and Bearded seals have the ability to metabolize small amounts of hydrocarbons so that such tissue damage is temporary unless the exposure is chronic over time (Kooyman, Gentry and McAlister, 1976). Although similar studies have not been done with walrus, their physiology is consistent with that of other Arctic seals. If walrus share this ability, some short term adverse impacts may be mitigated. Chronic exposure may still result in lethal effects or long term sub-lethal effects that reduce fitness.

Walrus at haulouts have been shown to be very sensitive to smells. In at least one case, walrus abandoned a beach apparently in response to a strong scent of perfume (ADFG, unpublished data). Walrus may avoid oil or oiled ice due to the smell, or may remain in the area in spite of the presence of oil. Studies on other seal species have indicated that seals intent on feeding will not avoid an area due to oil or oil sheens (Geraci and St. Aubin, 1990). Oil may impede the ability to dive by increasing buoyancy, which would in turn increase the energy expenditures of feeding, particularly for younger, smaller walrus. The VLOS scenario analyzes a light weight oil: 35° API. In general, lighter oils dissipate more quickly through evaporation, dissolution and dispersion. For comparison, the oil spilled in the Exxon Valdez spill was a medium weight oil with 27° API. Oil, especially heavy oils and weathered tarry oil, may impede swimming and diving by adhering to the walrus hide and reducing the ability of the animal to move its flippers efficiently. Sand, gravel or other debris may adhere to the oiled skin further impeding locomotion and impacting the walrus' ability to use their vibrissae to locate prey items along the sea floor.

Walrus primarily feed on benthic invertebrates, such as clams and marine worms. Benthic invertebrates that come into contact with the spill would ingest hydrocarbons from water, sediments and food. Invertebrates could concentrate contaminants because they metabolize hydrocarbons poorly. Long-term or chronic oil ingestion may result in kidney damage, liver damage, or ulcers in the digestive tracts of walrus. Depending upon the level of impacts to benthic invertebrates, walrus could be forced to travel farther to forage, resulting in increased energetic costs and perhaps increased competition among walrus for food sources.

Phase 3 (Onshore Contact)

Depending upon the location of the spill site and other factors, oil could contact shore within 10 days of the initial event. Walrus could come into contact with oil at coastal haulouts. Regardless of whether contact occurred at sea, on ice or on land, the results to the physical health of the walrus would be the same as those listed under Phase 2. If walrus avoid coastal areas that have been fouled by oil, they may be excluded from important coastal resting areas once the sea ice retreats off of the continental shelf in late summer. Walrus cannot remain at sea indefinitely; they must haul out to rest and regain body heat. Calves and young walrus are more restricted in the amount of time that they can spend at sea, and are unable to swim as far or for as long as adult walrus. This worst-case scenario could lead to population-level effects.

Phase 4 (Spill Response and Clean Up Activities)

Spill response and clean up activities would involve large numbers of boats of various sizes, skimmers, airplanes, and helicopters. In-situ burning and corralling oil with boom material, or booming off sensitive nearshore habitats may occur. Although the USCG has not previously approved the use of dispersants in the Arctic, their use is foreseeable. Dispersants could be ingested by benthic invertebrates, and have impacts similar to oil if ingested by walrus. Depending upon the type of chemical dispersant used, dispersants could also cause direct impacts to walrus by irritating eyes, mucous membranes, or respiratory systems. Dispersants could also cause indirect effects by killing prey species and displacing walrus from foraging areas.

In the initial aftermath of a spill, activity would be concentrated in the immediate area of the spilled oil. Walrus would likely avoid the area due to the large amount of noise and activity. Walrus, particularly females with young calves, are easily displaced by boat and aircraft traffic. This displacement which may reduce the likelihood that they would be oiled or be exposed to PAHs which tend to evaporate relatively quickly (within a few days, unless frozen into ice). Gas (primarily methane and ethane) would quickly dissipate into the atmosphere at the spill site and walrus are not likely to be exposed to gas in the event of an explosion and spill. Immediate responses, in addition to seeking to control the well and stop the flow of oil, may include attempts to cap the flow or repair the rupture. In-situ burning has been shown to be very effective with freshly spilled oil, but the oil becomes more difficult to ignite as it ages and the aromatic hydrocarbons burn or evaporate. In-situ burning would release soot and other pollutants into the air, but it is unlikely that walrus would remain in the vicinity of such activity or be exposed to enough smoke and soot to suffer respiratory effects.

As the spill response continues, the oil (and thus the response) will become spread out over a larger area. The amount of oil being discharged daily would decrease as the pressure remaining in the well decreases. BOEMRE has estimated that the flow of oil would decrease from a high of 60,000 bbls/day to just over 20,000 bbls/day over the 74 day spill duration analyzed in this VLOS scenario. Depending upon the location of the spill site and the time of the spill, BOEMRE estimates that a discontinuous area of 162,200 square kilometers (km2) to 547,600 km2 would be contacted by oil. As the spill continues, clean up efforts would likely focus on the spill site, villages and areas deemed to be critically important to fish or wildlife. If the spill begins early in the open water drilling season (mid-July), then the longer that the spill goes on, the more likely it becomes that walrus will encounter oil and/ or disturbance from clean up efforts. In recent years, walrus have retreated to coastal haulouts in September due to a lack of sea ice cover as a resting platform. If the spill occurs toward the end of the open water drilling season (late October) walrus may already be moving southward out of the Chukchi Sea and may be less likely to be impacted by oil or clean up efforts during that season (USGS, unpublished tagging data).

Even after the flow of oil has been stopped, responders would continue cleaning any remaining oil that can be located. Clean up efforts could focus on oiled shoreline, and hot washing methods or dispersants could be used. The coastlines being cleaned would be unavailable to walrus for resting. Dispersants may cause skin irritations, respiratory impacts or impacts to sensitive tissues around the eyes, nose, or mouth. This process may be continued the year following the spill. Oil frozen in ice over winter would melt out in the spring through brine channels and into leads and polynyas.

Skimmers and other methods may be used to try to capture this remaining oil the spring/summer following the spill. This could lead to additional disturbance to walrus in the ice pack, as well as exposure to oil when the walrus return in the spring. At that time of year, the females are calving and the calves may be especially sensitive to the effects of oil or disturbance. High rates of spontaneous abortions have been reported for some other marine mammal species after a spill, though it is unclear whether this is related to the spill itself or stress related to clean up activities or is an unrelated event (Geraci and St. Aubin 1990; and Kooyman, Gentry and McAlister 1976).

Phase 5 (Long Term Recovery)

After cleanup efforts have ceased, the remaining oil will continue to weather and be subject to microbial degradation. This process is likely to be very slow in Arctic waters. Oil that has been suspended in the water column or in the sediment may continue to be ingested by the benthic organisms that walrus prey upon. Walrus may continue to be exposed to hydrocarbons through their prey, which may lead to reduced fitness and possibly population-level effects over time.

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

Oil Spill Trajectory Analysis

A VLOS could contact offshore or onshore areas where walrus may be present. The degree of contact with oil would depend upon the location, timing, and magnitude of the spill. The OSRA model divides the 193 lease sale area into 13 launch areas (LAs) to model the spill trajectories from different sources of origin. The LAs are described in Appendix B, Figure B-10. In many instances, the differences between launch areas are less important than the magnitude of the spill given the large area that a VLOS could encompass.

The drilling season in the Chukchi Sea is the open water season, typically between July 15 and October 31. The VLOS scenario estimates for the purpose of analysis a spill duration of up to 74 days. Spilled oil could remain on the water surface for up to 3 weeks. A spill beginning early in the open water season and stopped within 39 days would, therefore, remain on the water surface for 60 days. A spill which started late in the open water season or was not stopped for 74 days would likely freeze into the ice and persist over winter, melting out in the spring. BOEMRE, therefore, analyzed a summer spill that persists for 60 days and 360 days, and a winter spill that persists for 360 days.

This section describes the results estimated by the Oil Spill Risk Analysis model (OSRA model) of a hypothetical very large oil spill in the Chukchi Sea contacting specific Environmental Resource Areas (ERAs), Land Segments (LSs) or Grouped Land Segments (GLSs) where walrus are likely to be found. An ERA is a polygon that represents a geographic area during a specific time period. The ERA locations are incorporated from the Sale 193 FEIS (USDOI, MMS, 2007a) and found in Appendix B, Figures B-1 to B-4. The ERAs are summarized in Appendix A, Tables A.1-13 through A.1-15 of the Sale 193 FEIS. The vulnerability of an ERA is based on the seasonal use patterns of walrus (Appendix A, Table A.1-12, USDOI, MMS 2007a). LSs and GLSs are sections of the coastline and are not seasonal. For this analysis, we do not consider the effectiveness of clean up methods. We make the assumption that if oil contacts the coastline, the oil will remain there until it breaks down via natural processes.

In the Sale 193 FEIS, the OSRA analysis focused on terrestrial walrus haulout locations at Cape Lisburne, on Wrangel Island, on Kolyuchin Island and along the Russian coastline of the Chukchi Sea. Since that time, walrus have begun hauling out in large numbers along the U.S. side of the Chukchi Sea coast as well. We also have additional information about at sea distribution from tagging studies and surveys. We have incorporated ERAs from the Sale 193 FEIS that were not used in relation to walrus at that time to capture this new information about where walrus may come into contact with oil. At large terrestrial haulouts, there are usually many walrus in the nearshore waters in the vicinity of the haulout. Where possible, we have used ERAs rather than land segments as a proxy for the terrestrial haulouts so that both the onshore and offshore components of the walrus associated with the haulout are represented. Although as many as 15,000 walrus have been recorded hauling out on the U.S. side of the Chukchi Sea in recent years; the largest walrus haulouts are still primarily on the Russian side of the Chukchi Sea, where haulouts of over 100,000 walrus may occur.

Walrus enter the Chukchi Sea in the spring time when the sea ice retreats, and return to the Bering Sea in late fall when the Chukchi Sea freezes. Where possible, we have used ERAs with a year round vulnerability (Jan-Dec) even though we recognize that walrus won't be present in the Chukchi Sea in December through late February. In the event that oil was to contact these ERAs in December through February, it would freeze into the ice and snow over winter and remain frozen in the ice until spring. The oil would then melt out of the thawing ice in the spring just as the walrus are returning to the area. Oil spreads under sea ice and adheres to the rough bottom of the sea ice, filling in depressions in the sea ice. In calm conditions, oil spreads beneath the surface of the sea ice. How much it spreads before becoming encapsulated in the ice depends upon the viscosity of the oil, and surface tension forces. In rough seas, oil may be pushed up on top of the ice, or broken up into droplets in the water column. Currents may also spread the oil below the surface of the ice or in open water. Emulsions of oil mixed with water will also freeze into the ice where they will remain until the spring melt season. In one experiment, oil released under first year ice in the Beaufort Sea became encapsulated in the ice and remained in place until spring (Fingas and Hollebone, 2003).

Summer Spills (June 1 – October 31)

The following information is summarized from Tables B-7, B-8, B-11, and B-12. A summer spill is defined as a spill taking place during the open water season between June 1 and October 31. The following discussion uses the geographic description and the corresponding ERA number can be found in Table 17. The OSRA model estimates that 2% or fewer of the trajectories launched during this time period would contact Wrangel Island or Kolyuchin Island within 60 days or within 360 days from LAs 1-13. The OSRA model estimates that 4% or fewer of the trajectories would contact any section of the Russian coastline in 60 days with one exception—12% of the trajectories from LA9 would contact some section of the Russian coastline, though not necessarily where walrus may be. Over 360 days, the percentage of trajectories that would contact some section of the Russian coastline is 6% or fewer, again with the exception of LA9 where the percentage of trajectories contacting the coastline would be 19%.

Table 17. Walrus habitat areas analyzed in the VLOS OSRA analysis.

ERA or GLS	Geographic Description	Period of Vulnerability	Figure in Appendix B
ERA 39	South of Pt Lay to Icy Cape	Jan–Dec	Figure B-2
ERA 40	Icy Cape to Peard Bay including Wainwright	Jan–Dec	Figure B-2
ERA 2	Pt Barrow, Plover Islands area	May–Oct	Figure B-2
ERA 59	Kolyuchin Island	May–Nov	Figure B-2
ERA 11	Wrangel Island with 12 mile buffer	Jan–Dec	Figure B-2
ERA 46	Herald Shoal polynya area	Jan–Dec	Figure B-2
ERA 48	Hanna Shoal polynya area	Jan–Dec	Figure B-2
ERA 20	Southern portion of Chukchi spring lead system	April–June	Figure B-3
ERA 21	middle portion of Chukchi spring lead system	April–June	Figure B-3
ERA 22	Northern portion of Chukchi spring lead system	April–June	Figure B-3
ERA 15	Cape Lisburne area	May–October	Figure B-4
GLS 95	Russian coastline, LSs 1-39	Jan–Dec	Figure B-5

On the U.S. side of the Chukchi Sea, results are more variable. The percentage of trajectories contacting the Pt. Barrow/Plover Islands area within 60 days is 2% or less from all launch areas except LA8 (9%) and LA13 (8%). Within 360 days, the percentage of trajectories contacting this area is 2% or fewer from all LAs except LA7 (6%), LA8 (13%) and LA13 (10%). For the Cape Lisburne area, 4% or fewer trajectories contact the area within 60 days with the exception of LA 9 (22%) and LA10 (19%). No additional trajectories would contact the coast between 60 and 360 days. For the Chukchi Sea spring lead system, 3% or fewer of the trajectories would contact the spring lead system within 60 days. Within 360 days, 4% or fewer trajectories will contact the spring lead system. The highest percentage of trajectories contacting the spring lead system is from LAs 10, 11 and 12.

Of the ERAs considered in the summer analysis for walrus, the most vulnerable areas in the event of a VLOS are the Point Lay and Point Wainwright subsistence areas and the Hanna and Herald Shoal polynyas. For the Point Lay subsistence area, the percentage of trajectories contacting the ERA within 60 days is 5% or fewer for all LAs except LA10 (18%) and LA11 (16%). Within 360 days the only additional contact would be an additional 1% if the VLOS were to originate in LA10. For the Wainwright subsistence area ERA, the percentage of trajectories contacting within 60 days is fewer than 5% for all LAs except LA5 (8%), LA10 (9%), LA11 (23%), LA12 (27%) and LA13 (7%). Over 360 days, the percentage of trajectories contacting the ERA is 5% or fewer from all LAs except LA5 (9%), LA6 (6%), LA10 (10%), LA11 (25%), LA12 (29%), and LA13 (9%). For the Herald Shoal polynya, the percentage of trajectories contacting the ERA within 60 days is 5% or fewer for most LAs, the exceptions are LA1 (7%), LA4 (21%), LA5 (9%), and LA10 (6%). No additional trajectories would contact the ERAs between 60 and 360 days except an additional 1% from LA4 or LA5. For the Hanna Shoal polynya ERA, only LAs 4, 9 and 10 have 5% or fewer trajectories contacting this ERA within 60 days. A VLOS originating in LA1 or LA8 would have 7% of the trajectories contacting the Hanna Shoal polynya ERA within 60 days; the rest are as follows: LA2 (15%), LA3 (18%), LA5 and LA7 (17%), LA6 (47%), LA11 (20%), LA12 (15%), and LA13 (8%). Between 60 and 360 days, an additional 1-5% of trajectories (depending upon LA) would contact the Hanna Shoal polynya ERA.

Winter Spills (November 1 – May 31)

The following information is summarized from Tables B-16, B-19, and B-20. A winter spill is defined as a spill taking place between November 1 and May 31, in other words, the trajectories would be launched during this time period. For a winter spill, we have only considered the full 360 day period. The OSRA model estimates that 4% or fewer of the trajectories launched during this time period would contact Wrangel Island or Kolyuchin Island within 360 days. The OSRA model estimates that 5% or fewer of the trajectories would contact any section of the Russian coastline in 360 days with the following exceptions: LA1 (6%), LA4 (12%), and LA9 (32%).

For the U.S. side of the Chukchi Sea, 6% or fewer of the trajectories from any LA would contact the Pt. Barrow/ Plover Islands area within 360 days. For the Cape Lisburne ERA, 5% or fewer of the trajectories from any LA would contact this ERA within 360 days. For the Chukchi Sea spring lead system, fewer than 6% of the trajectories would contact the spring lead system over 360 days with the following exceptions: LA10 (7-10%), LA11 (3-12%), LA12 (1-14%). For the Point Lay area ERA, fewer than 3% of trajectories would contact the ERA with the following exceptions: LA4 (6%), LA5 (7%), LA10 (25%), and LA11 (13%). For the Wainwright area ERA, fewer than 3% of trajectories would contact the ERA with the following exceptions: LA4 (7%), LA5 (10%), LA10 (18%), LA11 (19%), and LA12 (20%). For the Herald Shoal polynya ERA, 4% or fewer trajectories would contact this ERA over 360 days with the following exceptions: LA1 (8%), and LA4 (19%). The Hanna Shoal ERA has the highest percentage of trajectories contacting it of the ERAs considered here. For LA9, 3% of trajectories would contact this ERA. For LAs 1-4 and LA8, 11-20% of trajectories would contact the Hanna Shoal ERA. For LAs 7, 10 and 13, 23-28% of trajectories would contact Hanna Shoal. For LAs 5, 6, 11, and 12, 35-54% of trajectories would contact the Hanna Shoal ERA.

Conclusion

In the event of a VLOS, the OSRA model estimates most of the contact between oil and walrus habitat would occur on the U.S. side of the Chukchi Sea, while the bulk of the walrus population hauls out on the Russian side of the Chukchi Sea. Contact with oil on the U.S. side of the Chukchi Sea would be most likely to occur at Herald or Hanna shoals, or at coastal haulouts near Wainwright or Pt. Lay. Walrus are less vulnerable to injury from contact than are furred seals, but more likely to be subjected to long term chronic ingestion of hydrocarbons from eating benthic prey than are seals that eat fish. In the event of a VLOS, key habitats to protect for walrus would include the Herald and Hanna Shoal polynyas and the Wainwright and Pt. Lay areas. Significant impacts to the walrus population would be most likely to occur if large scale contamination of prey and habitat persisted for years.

As illustrated in the analysis above, hypothetical spills launched from LAs 10, 11 and 12 generally exhibit the highest potential for contact with the Hanna Shoal polynya, the Chukchi Sea spring lead system, and the Wainwright and Pt. Lay areas. LAs 8 and 13 are associated with slightly higher potential for contact with the Pt. Barrow, Plover Islands area. Deferring portions of LA9 could reduce the potential for VLOS contact with sections of the Russian coastline. By deferring these areas from leasing, the corridors in Alternative IV and (to a greater extent) Alternative III could reduce the potential for impacts to walrus and walrus habitats. The Pacific walrus population is currently estimated at a minimum of 129,000. If a VLOS were to occur and to contact large portions of habitat inhabited by walrus, calves of the year would most likely be at risk.

IV.E.12. Terrestrial Mammals

A VLOS is hypothesized to occur following a series of operational failures. Analysis of the hypothetical VLOS scenario described in Section IV.D.2 is divided into five phases: the Initial Event (Phase 1), Offshore Oil (Phase 2), Onshore Contact (Phase 3), Spill Response and Clean-up (Phase 4), and Long Term Recovery (Phase 5). These phases and the types of impacts that could occur during each are discussed sequentially. A discussion of the percent oil spill trajectories contacting various areas important to terrestrial mammals is then provided.

A VLOS in the Chukchi Sea could negatively affect terrestrial mammals in the region. The greatest potential for large-scale effects on several species of terrestrial mammals occurs during Phase 3, when spilled oil may contact Land Segments (LSs) that are used by mammal species including caribou, grizzly bears, muskox, and various furbearer species. With the exception of caribou, terrestrial mammals do not aggregate in coastal areas in numbers sufficient to permit population level effects to occur from oiling.

Phase 1 (Initial Event)

The initial event is a well-control incident and blowout that could lead to an explosion, fire, sinking drill rig, and the redistribution of sediment and drilling wastes in the local area. This Phase does not include the release of oil (Phase 2) or spill response/cleanup (Phase 4). The proposal area in the Chukchi Sea is too far offshore for any Phase 1 events to be detected by terrestrial mammals. While some smoke could be produced by a fire, there should be no deleterious effects on terrestrial mammals, since particulate matter will disperse into the atmosphere around a drilling rig.

Phase 2 (Offshore Oil)

Terrestrial mammals by definition use onshore areas to a greater extent than offshore areas. However, some terrestrial mammals use sea ice to hunt and scavenge during winter. Consequently, they could be exposed to offshore oil at certain times of the year. Grizzly bears are known to venture out onto the sea ice during spring to predate seals (Doupé et al., 2007; Taylor 1995; Struzik 2003; Lindsay 2009; Doupé 2005; Wolkow 2005). Arctic foxes range far over the shorefast and pack-ice scavenging polar bear kills, and hunting when they can. Wolverines do not travel as far onto the ice as Arctic foxes, but are known to hunt ringed seals in some areas. As described in Section IV.C.1.i(4)(d) of the Sale 193 FEIS, terrestrial mammals may experience physiological effects from ingesting oiled food items, oiling of their fur, and ingesting oil via grooming. The most likely means for a terrestrial mammal to contact spilled oil in the offshore environment involves ingesting contaminated meat from a kill/carcass, or through accidentally getting their fur oiled. While they are good swimmers, the Arctic waters are probably too cold for grizzly bears, foxes, or wolverines to regularly swim for any significant amount of time during winter, although Arctic foxes will swim between barrier islands during the summer. Caribou are unlikely to ingest oiled vegetation since they are very selective feeders (Kuropat and Bryant 1980), however grizzly bears and scavengers may not be particular with regard to their foods. If salmon runs were contaminated, the effects may affect multiple grizzly bears. A VLOS in the Chukchi Sea may be a threat to these species if long-term exposure occurs, if they ingest significant quantities of oil, or if their fur becomes oiled and compromises its insulating capacity.

Phase 3 (Onshore Contact)

Caribou, muskoxen, grizzly bears, and furbearers could be affected by spills contacting coastlines; however, any actual chance of animals contacting oil from a VLOS would be a function of animal numbers, densities, the season, the size of the oiled area, etc. As described in Section IV.C.1.i (4)(d) of the Sale 193 FEIS (USDOI, MMS, 2007a), terrestrial mammals may experience physiological effects from exposure to an oil spill through oiling of their fur and ingesting oiled food items.

A VLOS in the Chukchi Sea may be a threat to terrestrial mammal species if long-term exposure occurs, they ingest significant quantities of oil, or if their fur becomes oiled and compromises its insulating capacity. The greatest risk of contact would most likely come from ingesting oil through contaminated food items, or grooming oiled fur. Caribou are unlikely to ingest oiled vegetation since they are very selective feeders (Kuropat and Bryant, 1980); however, grizzly bears and scavengers may not be particular with regard to their foods. If salmon runs were contaminated or otherwise affected as described in Section IV.E.5, multiple grizzly bears may be affected. If caribou in insect relief areas become oiled, there is a chance that they could ingest some oil when grooming themselves; however, crude oil is a very noxious substance, and caribou may be more likely to rub it off on vegetation or land features, rather than licking it from their fur.

Contact with Oil

The effects of terrestrial mammals contacting crude oil were described in Phase 2, and on page IV-176 of the Sale 193 FEIS (USDOI, MMS, 2007a).

Contamination

The two primary routes of oil contamination for terrestrial mammals are ingestion and oiling of fur. Because the Arctic is a very cold environment, terrestrial mammals rely on dense coats of fur for warmth. While some species such as the grizzly can put on extensive amounts of body fat and hibernate to overwinter, others such as Arctic foxes and wolverines do not, and so remain active year-round. Caribou and muskox put on some body fat before winter, but only after grazing on vegetation for an entire summer and into the fall. If the fur of most species of terrestrial mammals were to become oiled they might attempt to rub the oil off onto another medium such as soils, rocks, or vegetation, or they could attempt to lick themselves clean. If the latter were to occur, these animals might ingest quantities of oil or hydrocarbons sufficient to cause permanent injury or death. Likewise it has been hypothesized that terrestrial mammals might accidentally ingest oil while grazing on vegetation that has been oiled or, in the case of predators, by consuming an oiled carcass. Section IV.C.1.i(4)(d) of the Sale 193 FEIS (USDOI, MMS, 2007a) analyzes and summarizes the effects of an oil spill on terrestrial mammals in greater detail.

Loss of Access to Food

A VLOS event should not affect the availability of forage for herbivores such as caribou or muskox, since they can readily travel a short distance to an un-oiled patch of vegetation. The risk is greatest with grizzly bears and other predators, since passing up a contaminated carcass or kill could have serious implications for their nutritional status at a critically important time. A decrease in nutritional status could have subsequent repercussions on overall fitness and ability to survive in the harsh environment, especially when there is no guarantee another similar food would be available in the near future.

Loss of Access

Unless large numbers of marine mammals, birds, and fishes are killed by a VLOS, there should be no immediate change in access to additional carcasses and other food for terrestrial mammals. However, any adverse impact to salmon stocks could have effects on the ability of grizzly bears, wolves, etc. to secure sufficient food permitting their continued survival. The loss of salmon runs could also have long-term effects on streamside vegetation such as willows and graminoids by limiting or removing annual nutrient surge into an otherwise nutrient-poor system. The consequences of the loss of a seasonal nutrient input into a community could then affect the quality, and perhaps quantity, of the forage base for species such as muskoxen and caribou.

Phase 4 (Spill Response and Cleanup)

Spill response activities could disturb and displace marine and coastal areas, which could act to displace terrestrial mammals away from an oiled area.

The effects of vessel and aircraft traffic associated with an oil spill response and cleanup may startle caribou, muskoxen, grizzlies, or wolves as described in the Sale 193 FEIS (USDOI, MMS, 2007a), Sections IV.C.1.i(4)(d)(2)b) and IV.C.1.i(3). Activities such as in-situ burning and animal rescue could have additive effects, most likely displacing animals to a slightly greater degree. However, it is also likely bears and scavenger animals could be disturbed while feeding on carcasses, potentially creating unwanted bear-human conflicts. Cleanup activities such as beach cleaning may be performed with a high degree of success using newer technologies (Painter, 2011). However other activities such as spill cleanup under ice or in areas of broken ice may be more problematic. The effects of these activities on terrestrial mammals would vary, depending upon the extent of coastal area exposed to hydrocarbon contaminants, scale and timing of the spill response, and pre-existing stresses (insect relief period, nutritional status, etc.).

Phase 5 (Long-term Recovery)

Long-term is defined as an effect that continues in populations for more than 2 years. The immediate effects of short-term oiling are not expected to persist beyond a few months. If anadromous fish stocks are heavily affected there could be associated effects on bears and wolves that may rely on salmon as part of their annual food budget. Further, if anadromous fish survive, but are contaminated with toxins like PAHs, they can continue to be source of contamination for terrestrial species, especially predators (Krummel et al., 2003). Long-term effects could include the removal of annual nutrient inputs in the rivers and streams supporting several mammal species and riparian vegetation, and over time it could have effects on other ecological communities. Even if several thousand caribou were immediately killed as a result of a VLOS those numbers would most likely be replenished within one year or two on the outside. Muskox do not frequent most coastal areas and so should not be at risk from a very large spill event, while predators such as grizzly bears, wolves, and foxes, etc. normally occur in very small numbers that would not result in population level effects lasting beyond a year or two.

Oil Spill Trajectory Analysis

Grizzlies, furbearers, caribou and muskoxen would only be affected at very specific land segments during the summer, open-water season or by consuming oiled food items in the coastal zone in the event of a spill. As described in Section IV.C.1.i(4)(d) of the USDOI, MMS (2007a), terrestrial mammals may experience physiological effects from exposure to an oil spill through oiling of their fur, and ingesting oiled food items. A VLOS in the Chukchi Sea may be a threat to these species if long-term exposure occurs, if they ingest significant quantities of oil, or if their fur becomes oiled, compromising its insulative abilities. The greatest risk of contact would most likely come from ingesting oil through contaminated food items, or grooming oiled fur.

Within 60 days for a summer spill the estimated discontinuous area contacted is between 245,800 and 364,100 km2 and within 360 days 264,500 to 450,400 km2 (Appendix B, Table B-5). Winter spills are more restricted in area within 60 days covering a discontinuous area contacted of 162,200 to 385,600 km2, and within 360 days 368,400 to 507,200 km2 (Appendix B, Table B-6). Such patchiness in a spill would likely affect the quantity of oil that reaches shore, and the number of animals that may be contaminated, due to uneven levels of habitat use along the Chukchi and Beaufort Sea coastlines.

A very large spill could contact offshore and nearshore areas terrestrial mammals may frequent. The percentage of trajectories contacting the resouce would depend on the location, timing, and magnitude of the spill, ocean currents, weathering, and other factors. The OSRA model uses 13 launch areas (LAs) to model the origination of spill trajectories. The LAs are described in Appendix B, Figure B-10. A VLOS continuing after 31 October is treated as a winter spill. Oil could still be released during this period, so 360 days is the most conservative assessment period for this hypothetical situation.

The drilling season is typically July 15 through October 31 in the Chukchi Sea. This time period is typically when any spills from drilling would occur. In the unlikely event of a well blowout leading to a VLOS, BOEMRE has determined from 39 to 74 days would be required for another drilling unit to transit to the site and drill a relief well.

In the event of this VLOS not all of the hydrocarbons are discharged at once, unlike what occurs with marine accidents such as the Exxon Valdez Oil Spill in Prince William Sound, Alaska. Instead they flow into the ocean at rates that decrease over time. For the briefest spill period BOEMRE estimates that a spill could persist on the surface of the water for up to three weeks, and so a 60-day period of potential contact was analyzed. However if a spill were to occur late in the open water season, the liquid hydrocarbons may freeze into the sea ice, and remain overwinter without any extensive amount of weathering. If this were to happen quantities of un-weathered oil could end up being transported to different areas in the Chukchi and Beaufort Seas and be released in the spring. To address concerns such as this BOEMRE has also analyzed a 360-day period. The environments of the Chukchi and Beaufort Seas are such that an effective oil spill response is likely under favorable conditions. However periods of bad weather and/or too much sea ice could hamper or prevent an effective oil spill response, particularly if the spill lasted into winter. An approved OSRP would be required for all drilling activities prior to issuance of a permit by BOEMRE.

This section describes the results estimated by the OSRA model of a hypothetical very large oil spill in the Chukchi Sea contacting specific LSs that have importance to terrestrial mammals. During winter caribou and muskoxen will be inland at their wintering areas, and grizzly bears will be hibernating. However in the early spring grizzly bears are known to move out onto the ice, killing and feeding on ringed seal pups. Furbearers such as Arctic foxes, wolverines, etc. are also known to travel extensively on the ice in some areas, feeding on marine mammal carcasses, and any individuals that they can kill.

The following paragraphs present the results (expressed as a percentage of trajectories contacting) estimated by the OSRA model of a hypothetical very large spill contacting habitats that are important to terrestrial mammal species. For example a very large spill during winter from any launch area could hardly be expected to directly affect caribou within 60 days since they migrate inland to winter habitat. However they could come into contact with spilled oil by June or July of the following year, since it would be within 360 days of the spill date, though by that time most of the hazardous components of a spill will have weathered away.

The OSRA model estimates from any individual LA which may have a ≥1% of trajectories contacting Land Segments (LS) with importance to terrestrial mammals within 60 days (Tables B-1, B-9,, B-15 and B-18), and 360 days (Tables B-2, B-10, B-16, and B-19). Due to differences in summer habitat use between the different species in the analysis area, each species will be analyzed independently. Wolves, foxes, wolverines, etc. are addressed under the heading furbearers, while the remainder of the species are addressed at the species level. These analyses consider the 60 and 360-day time periods for a very large oil spill spills occurring during summer, and the winter unless otherwise noted. To focus on significant impacts (or elevated potential for significant impacts), only percentages of trajectories ≥ 5% are discussed.

Caribou

Caribou from the WAH, CAH, PCH, and TCH calve on the Arctic Coastal Plain (ACP) a short distance from the coasts in the relatively flat coastal plain. The ACP is riddled with shallow lakes, ponds, streams, and puddles, all of which create ideal breeding habitat for hordes of mosquitoes, which have been known to force caribou onto barrier islands, to coastal areas, or into the surf in an effort to gain relief from their torment. During the peak insect harassment season (July to mid August) caribou seek insect relief along coastlines and river deltas, barrier islands, mudflats, lake margins, gravel bars, snow and aufeis fields, and on windy mountain slopes and ridges. Most caribou visit insect relief areas along the coasts although sizable portions of the PCH move into the Brooks Range foothills during summer for insect relief, and by early August most of the PCH is scattered into the Brooks Range and into Canada. The primary land segments where insect relief most frequently occurs include LS 62-71 (WAH), 82-83 (TCH), 95-103 (CAH), and 103-109 (CAH & PCH).

A very large oil spill remaining in the offshore area should have no identifiable effects on caribou. For the onshore contact phase none of the land segments identified as insect relief areas have ≥5% trajectories contacting within 60 and 360 days summer or winter.

Muskox

The muskox population in northeastern Alaska, including ANWR, has been decreasing for several years partially due to predation by grizzly bears. Muskoxen also occur in coastal areas from Prudhoe Bay to the Seward Peninsula, though they do not seek insect relief as do caribou. It is highly unlikely any muskox would come into contact with a VLOS since their primary summer habitat is composed of riparian areas, and willow thickets or windswept uplands with easy access to quality forage plants during winter and spring. During winter and spring calving they prefer windswept upland areas that provide easy access to quality forage species. Although some individuals may be seen on the coasts, or on barrier islands, such occurrences are atypical and infrequent. LSs that have been identified as important coastal habitat areas for muskox include LSs 59-61.

A very large oil spill remaining in the offshore area should have no identifiable effects on muskox. For the onshore contact phase none of the land segments identified important to muskox have ≥5% trajectories contacting within 60 and 360 days summer or winter.

Grizzly Bear

The highest densities of grizzly bears in the analysis area occur in the mountains and foothills of the Brooks Range, but some individuals occur in coastal areas, particularly around salmon spawning streams. Coastal concentrations may be found when salmon runs occur in the Pitmegea and other rivers (LSs 67-68), and when marine mammal carcasses that wash ashore between Cape Seppings and Cape Thompson (LSs 61-64) and between Cape Lisburne and Kasegaluk Lagoon (LSs 65-75). The fact that grizzly bears hibernate makes them highly unlikely to contact oil from a VLOS during within 60 days during winter, however after they emerge from their dens in April and May they may wander out onto shorefast sea ice to predate ringed seals as has been reported in Canada (Doupé et al., 2007; Struzik, 2003; Taylor, 1993) and could come into contact with spilled oil.

Still, a VLOS remaining in the offshore area should have no identifiable effects on the grizzly bears population.

For the onshore contact phase none of the land segments identified important to grizzlies have ≥ 5% trajectories contacting within 60 and 360 days summer.

Winter within 60 Days. During the period covered by a 60 day winter spill, grizzly bears will be hibernating inland from the coasts in sites that provide safe, dry conditions. An oil spill trajectory analysis for this period is not provided.

Winter within 360 Days. During winter within 360 days LS 73 has ≥ 5% of trajectories from LA1-LA13. The OSRA model estimates a 8, 10, 7, 7, 12, 14, 6, or 5% trajectories contacting ERAs 19 to 23 (Chukchi Spring Lead System) within 360 days from LAs 5, 10, 11, 12, or 13 (Table B-16, Appendix B). This Chukchi spring lead system would only factor into the trajectory analysis for grizzly bears if a bear were foraging for seals on the ice in the early spring, and came into contact with oil, or ingested oil from a kill or carcass.

Furbearers

Wolves spend most of their lives in Arctic foothills, not normally inhabiting the Arctic coastal areas. Red foxes exhibit a similar preference for hills and upland areas over wetter coastal areas, although some have been known to den in dry areas around the coast. Arctic foxes show habitat preferences for drier areas near the coast and commonly go out onto the shorefast and pack ice to scavenge and sometimes hunt for their food. They are known to kill ringed seal pups if they can get to them, however well placed and constructed subnivean lairs make predation activities on seal pups difficult. Wolverines range widely and can be found anywhere on the Arctic coast throughout the year, and in the winter they may even venture onto ice to hunt or scavenge. Wolves and red foxes should not be affected in any way by a VLOS due to their habitat restrictions; however, Arctic foxes are ubiquitous on sea ice and the coastal areas of the Chukchi and Beaufort Seas. If a VLOS were to occur a number of Arctic foxes could become oiled, which may compromise the thermal characteristics of their fur, perhaps leading to hypothermia and/or death. Wolverines could also come into contact with a VLOS, particularly during winter, however wolverines require very large areas for their home ranges, and are quite unlikely to come into contact with a VLOS at any time of the year, particularly in numbers resulting in population level effects. Considering the dispersed populations and diverse habitat preferences of Arctic foxes and wolverines, along with their propensity to travel great distances, their analyses will focus on Grouped Land Segments (GLSs) rather than LS's, and include the 60-day time period for a VLOS. Arctic foxes are very common in Alaska, and could be expected on areas of sea ice that may be contaced by a spill. In contrast wolverines are scarce and solitary by nature and are unlikely to come into contact with spilled oil. It would be pointless to analyze ERA's for Arctic foxes or wolverines because of the ubiquitous distribution of Arctic foxes or the scarcity of wolverines.

Any spills during the VLOS winter 60-day could affect polynya areas, lead systems, shear zones, and other areas of biological importance to Arctic foxes and wolverines, most likely oiling or killing a few

Arctic foxes. Considering the reproductive capabilities of Arctic foxes, any such losses should not have detectable population level effects, and any losses would probably be replaced within one year. No more than one or two wolverines should be affected by a winter VLOS lasting 60 days. While wolverines venture out onto ice in some areas, they are not known to travel far onto the pack-ice or to wander, as do Arctic foxes. Wolverines maintain well established territories occupying large spatial areas making occurrences of more than one wolverine highly unlikely, and consequently very few wolverines should be affected by a VLOS event.

A very large oil spill remaining in the offshore area should have no identifiable effects on furbears. The percentage of trajectories contacting furbearer resouces onshore are summarized as follows:

Summer within 60 Days. The OSRA model estimates 12% of trajectories from LA9 contact the Russian Chukchi Coast, and 14 and 15 percent of trajectories from LAs 8 and 13, respectively contact any portion of the U.S. Beaufort Coast (Appendix B, B-11). The U.S. Chukchi Coast has 5, 9, 6, 5, 9, 24, 26, 26, or 17 percent of trajectories contacting from LAs 4, 5, 6, 8, 9, 10, 11, 12, or 13 respectively.

Summer within 360 Days. The OSRA Model estimates 6, 6, 19, or 6% trajectories contacting Russian Chukchi Coast from LAs 4, 8, 9, or 10. A spill from LAs 4, 5, 6, 7, 8, 9, 10, 11, 12, or 13 would have a corresponding 6, 11, 8, 9, 9, 9, 25, 28, 31, or 20% trajectories contacting any point on the U.S. Chukchi Coast (Appendix B, B-12). The U.S. Beaufort Coast would have a 7, 20 or 19% chance of being contacted by a VLOS from LAs 7, 8, or 13 respectively.Winter 60-Day:

Winter within 60 Days. The OSRA Model estimates 8% of the trajectories from LA9 contact the Russian Chukchi Coast, while the U.S. Beaufort Coast has ≤5% of trajectories contacting. The OSRA model estimates LAs 10, 11, and 12 have a 17, 9, and 7 percent of trajectories contacting the U.S. Chukchi Coast. Winter 360-Day:

Winter within 360 Days. The U.S. Chukchi Coast has 8, 12, 5, 28, 21, 20, or 9 percent of trajectories contacting from LAs 4, 5, 6, 10, 11, 12, or 13 respectively. LA 1 has 6 percent of trajectories contacting the Russian Coast, and LAs 4, 9, and 10 have a corresponding 12, 32, or 5 percent of trajectories contacting the Russian coast. The United States Beaufort Coast has 6, 9, and 10 percent of trajectories contacting LAs 7, 8, 12, or 13 (Appendix B: Figure B-10 and Table B-20).

Conclusion

Terrestrial mammals should not be significantly affected by a VLOS event. Caribou are the only species occurring onshore in the proposal area that might be affected in numbers greater than 1,000; however, this level of impact is unlikely. If a worst case scenario was to occur and several thousand caribou were to succumb to the effects of oil contamination, the herd sizes are sufficient to recover from losses within one and no more than two years. Grizzly bears in the Alaskan Arctic require extremely large home ranges to meet their needs. Consequently a VLOS is unlikely to involve more than a few bears at most. If those bears were to die as a result of consuming an oiled marine mammal carcass, contaminated salmon, or through grooming oiled fur, their home ranges could be reoccupied by other bears within that same season, and the population recovery would most likely occur within a year or two.

Effects on local muskox populations should also be small since they do not occur in large numbers, spending much of their time inland and away from the coast. The effects on furbearers such as foxes, wolves and wolverines would also be short-term since they either produce large litters (foxes), or occur in very low densities (wolverines, wolves). Any losses to fox populations would quickly be replenished, while the low population density and large home-ranges of wolverines and wolves would act to prevent more than a very few individuals from being exposed to a VLOS.

The presence of oil spill cleanup crews and the associated oil spill response activity (aircraft, landing craft, nearshore boats, etc.) should effectively haze most terrestrial mammal species from contaminated areas or sites. By unintentionally disturbing the animals, responders may provide a positive benefit by forcing those animals away from the spill and potential contamination.

If Alternative IV is selected, portions of LA's 8–13 would be deffered, and if Alternative III is selected larger portions of LA's 8–3 would not be available for lease under Sale 193. As the above analysis demonstrates, hypothetical spills emanating LASs 8–13 exhibit a comparatively higher potential for contact with nearshore and onshore areas used by terrestrial mammals. Should portions of these LAs be deferred from leasing, the consequences to terrestrial mammals would be smaller chances of spills originating in the affected LAs, and smaller probabilities of spills contacting shorefast ice, LSs and some ERAs. The larger deferral associated with Alternative III has greater potential to reduce impacts as compared with Alternative IV. A slightly larger potential for impacts would occur under Alternative I.

IV.E.13. Vegetation and Wetlands

Contamination of coastal vegetation and wetlands would likely occur during a VLOS and associated cleanup efforts. The potential for spilled oil to contact vegetation and wetland environments is influenced by timing of a VLOS, the seasonal effects of currents and subsequent advection of oil, timing and duration of oil spill, presence or absence of fast or pack ice, and general weather patterns (wind and storm events). The Chukchi Sea shoreline is characterized by small tides and moderate winds of the region (Sale 193 FEIS Section III.A.), creating a low potential for spilled oil to reach beyond the intertidal area. Seasonal storm events could force oil into upper shoreline areas and inside delta areas (Reimnitz and Maurer, 1979). Placement of booms around sheltered embayments and streams where diadromous and marine fish species congregate could prevent loss of fish, their habitat, and benthic communities that support their ecosystems. The occurrence of shore fast ice along the coastline of the Chukchi Sea prevents the growth of aquatic macrophytes in many littoral areas.

Phase 1 (Initial Event)

There are no potential impacts to vegetation and wetlands from the initial blowout event.

Phase 2 (Offshore Oil)

There are no potential impacts to vegetation and wetlands from contact to oil in offshore areas.

Phase 3 (Onshore Contact)

At Phase 3, direct exposure to oil is an impact producing factor that can affect vegetation and wetlands. The potential of oil from a VLOS contacting the coastal vegetation and wetlands would be dependent upon timing of a VLOS, the seasonal effects of currents and subsequent advection of oil, timing and duration of oil spill, presence or absence of fast or pack ice, and general weather patterns (wind and storm events). The amount of impact would be a function of the size of the oiled area and the duration of the VLOS.

Oil stranded on beaches may occur only on the surface, or it could penetrate into subsurface layers. Permeable substrates, generally associated with larger sand grain sizes, and holes created by infauna could increase oil penetration, especially that of light oils and petroleum products. Penetration into coarse-grained sand beaches may occur at a depth of 25 cm (5 in) (Pezeshki et al., 2000). Light oils may penetrate peat shores; however, peat resists penetration by heavy oils (NOAA, 2000). Although any residual oil that could remain following cleanup might be largely removed in highly exposed locations through wave action, oil could remain in the shallow subsurface for extended periods of time. In some locations, oil might become buried by new sand or gravel deposition. Natural degradation and persistence of oil on beaches are influenced by the type of oil spilled, amount present, sand grain size, degree of penetration into the subsurface, exposure to weathering action of waves, and sand movement onto and off shore. Although petroleum-degrading microbial communities are present, biodegradation along Arctic coastlines would likely be slow (Price, Owens and Sergy, 2002; Braddock, Lindstrom and Price, 2003) and is limited to only a few months per year. Spilled oil could persist for many years, with continued effects on potential recovery of infaunal communities (USDOI, MMS, 2003). On sheltered beaches, heavy oiling left for long periods could form an asphalt pavement relatively resistant to weathering (Hayes et al., 1992; 1993). Lagoon shorelines include low-energy beaches where spilled oil would likely persist for many years. Spilled oil may persist for extended periods on peat shores; however, if cleaned up, it would be expected to persist for less than a decade (Owens and Michel, 2003). If the spill reached shoreline areas, the probability of adverse impacts on the tundra and marshes would depend on wind and wave conditions. 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 the oil slick sinks into the root system (Jin et al., 2002). Impacts to wetlands from a VLOS oil slick in the vicinity of the coast during a storm surge could result in injury or mortality of vegetation and invertebrates in or on the substrate. Other effects of spills could include a change in plant community composition or the displacement of sensitive species by more tolerant species. Impacts to soil microbial communities might result in long term wetland effects, and wetland recovery would likely be slowed. Impacts to wetland vegetation may cause plant mortality and loss of wetland areas.

Various factors influence the extent of impacts to wetlands. Impacts would depend on site-specific factors at the location and time of the spill. The degree of impacts are related to the oil type and degree of weathering, the quantity of the spill (lightly or heavily oiled substrates), duration of exposure, season, plant species, percentage of plant surface oiled, substrate type, soil moisture level, and oil penetration into the soil (Hayes et al., 1992; Hoff, 1995; NOAA, 1994; Pezeshki, Hester, Lin et al., 2000). Higher mortality and poorer recovery of vegetation generally result from spills of lighter petroleum products (such as diesel fuel), heavy deposits of oil, spills during the growing season, contact with sensitive plant species, completely oiled plants, and deep penetration of oil and accumulation in substrates. Vegetation regrowth and recovery are generally better where oil spills occur in flooded areas or on saturated soils, than on unsaturated soils (BLM, 2002). Coastal wetlands in sheltered areas (such as embayments and lagoons) and that are not exposed to strong water circulation or wave activity, would be expected to retain oil longer with longer-lasting effects on biota (Culbertson, Valiela, Pickart et al., 2008).

Phase 4 (Spill Response and Cleanup)

Spill cleanup operations might adversely impact coastal beaches if the removal of contaminated substrates affects beach stability and results in accelerated shoreline erosion. Vehicular and foot traffic during cleanup could mix surface oil into the subsurface, where it would likely persist for a longer time. Manual cleanup rather than use of heavy equipment would minimize the amount of substrate removed due to effects of motorized vehicles on fragile tundra soils. Skimming, booming, in-situ burning, and other spill response and cleanup operations can be effective means of preventing offshore oil spills from reaching coastal wetlands and other vegetation. However, spill response activities could also disturb, trample, or otherwise damage these resources through the transportation and use of equipment. The effect would be similar to the temporary impacts associated with pipeline construction, shorebase construction, and vessel traffic. These temporary losses of vegetative resources would be minimized through appropriate spill response planning and protocols.

Phase 5 (Long-term Recovery)

Long-term is defined as an effect that affects populations for more than 2 years. Long term effects are possible for coastal areas due to severity of the VLOS and OSRA projections. Storm surges are a concern. In 1970, Reimnitz and Maurer (1979) observed the effects of tidal surges from a major storm event that inundated low-lying tundra and delta regions on the Beaufort Sea shoreline, leaving debris lines from flotsam as far as 5,000 m (16,500 ft) inland. A storm of equal or greater magnitude could force weathered oil far inward and leave residue over wide areas of tundra and river shores. In such cases, full recovery of wetlands, including invertebrate communities, may require more than 10 years depending on site and spill characteristics (Culbertson et al., 2008). Oil could remain in some wetland substrates for decades, even if it was cleaned from the surface. Heavy deposits of oil in sheltered areas of coastal wetlands or in the supratidal zone could form asphalt pavements resistant to degradation (Culbertson et al., 2008).

Oil Spill Trajectory Analysis

The following paragraphs present the results (expressed as a percent of trajectories contacting) estimated by the OSRA model of a hypothetical very large oil spill contacting coastal areas. The probability of an oil spill contacting the coastal areas would depend on the location, timing, and magnitude of the spill, ocean currents, weathering, etc. The OSRA model uses 13 launch areas (LAs) to model the origination of spill trajectories (Appendix B, Figure B-10). The Chukchi Sea summer season (open-water season) lasts from 15 July to October 31, and is when any drilling related spills would occur. In the unlikely event of a well blowout, BOEMRE has determined from 39 to 74 days would be required for another drillship to transit to the site and drill a relief well. In the event of a VLOS not all of the hydrocarbons are discharged at once. They flow into the ocean at rates that decrease over time. For the briefest spill period BOEMRE assumed that a spill has a 3 week discharge window, and so a 60 day period of potential contact was analyzed. However if a spill were to occur late in the open water season, the liquid hydrocarbons may freeze into the sea ice, and remain overwinter without any extensive amount of weathering. If this were to happen un-weathered oil could be transported to non-spill zone areas in the Chukchi and Beaufort Seas and be released in the spring. To address concerns such as this BOEMRE has also analyzed a spill window of 360 days. A VLOS continuing after 31 October is treated as a winter spill. Oil could still be released during this period, so 360-days is the most conservative assessment period for this hypothetical situation.

As explained above, most segments of Chukchi Sea lack vegetation and are summarized here as coastal barrens. The coastal barrens include the following 13 shorelines types (Table A.1-8 of the Sale 193 FEIS): exposed rocky shore; exposed solid man-made structures; exposed wave-cut platforms in bedrock, mud or clay; fine to medium-grained sand beaches; tundra cliffs; coarse grained sand beaches, mixed sand and gravel beaches; gravel beaches; exposed tidal flats; sheltered rocky shore and sheltered scarps in bedrock, mud or clay; sheltered solid man-made structures; peat shorelines; sheltered tidal flats; and other unranked shores. Due to the physical components of coastal barrens, lack of fauna and flora, and the presence of underlying permafrost, oil spill slicks may be cleaned more effectively in these areas. The predominance of shore fast ice along these shorelines precludes most vegetation and benthic fauna from establishing themselves on the coastal barrens.

This analysis focuses on coastal areas featuring more valuable vegetation and wetland communities: sheltered vegetated low banks (9B) and salt/brackish water marshes (10A). These communities contribute more to the higher trophic-levels and are a higher source of nutrients to the surrounding waters than the coastal barrens because they include vegetation and animal life. They are included in Table A.1-8 of the Sale 193 FEIS are the two remaining shoreline types for OSRA analysis. These two types are only considered in the application of the OSRA at Land Segments (LSs) where either one comprised 5% or more sheltered vegetated low banks and salt/brackish water marshes of the coastal area are considered in the for each LE.

Sheltered Vegetated Low Banks

LSs featuring 5% or more sheltered vegetated low banks include: Kuchaurak and Kuchiak Creek LS70 (9%); Kukpowruk River, Noakok, Sitkok Point LS71 (7%); Kokolik River, Point Lay, Siksrikpak Point LS72 (19%); Tungaich Point, Tungak Creek LS73 (8%); Kasegaluk Lagoon, Solivik Island, Utukok River LS74 (9%); Akeonik, Icy Cape LS5 (18%); Avak Inlet, Tunalik River LS76 (7%); Nivat Point, Nokotlek Point LS77 (9%); and Point Belcher, Wainwright, Wainwright Inlet LS79 (11%). For summer spills, the OSRA model estimates that within 60 days, 1% of the spill trajectories from LA 4 would contact LS74 and LS75. One percent is also the estimated percent trajectories starting at LA5 would contact LSs 73-75 and LS76. An estimated <1-4% of trajectories applies to the following: LA 10, with regard to LSs 70-75, 77, and 79; LA 11 iwith regard to LSs 71-77 and 79; and LA 12, with regard to LSs 74-77 and 79. Within 360 days the OSRA model estimates that 1-2% of the spill trajectories starting at the following LAs would contact the indicated LSs: LA4 with regard to LS73-75; LA5 with regard to LS73-75, and LS77; and LAs 5-8 with regard to LS79. For winter spills, the OSRA model estimates that within 60 days, 1-4% of the spill trajectories starting at LA10 would contact LS70-75. This estimate also applies for LA11 with regard to LSs 72-75 and LS79, as well as to LA12 with regard to LS79.

Salt/Brackish Water Marshes

The only LS with coastal area of 5% or more salt/brackish water marshes that could be impacted by the VLOS is Kuchaurak and Kuchiak Creek (LS 70), 10% of which is comprised of these resources. For all hypothetical spill (summer and winter, 60 days and 360 days), the OSRA model estimates that 1% of spill trajectories starting at LA10 would contact LS70.

Conclusion

Potential impacts from spills would be expected to occur from the direct effects of oil on coastal vegetation and wetlands. Shoreline and inundated areas of vegetation lost to the effects of a VLOS would recover slowly, providing an opportunity for accelerated erosion during recovery time. Tundra and marsh areas would be affected if the onshore contact is concurrent with a storm-surge. Oil contamination could persist for 10 years or more during which time the oil in the sediments could be slowly released back into the environment as a result of erosion or exposure of oiled sediments and soils. Response and clean-up efforts have the potential to cause negative effects by exposing shoreline areas to anthropogenic disturbance. Overall, the effects of oil exposure on vegetation and wetlands could take 2-10 years for recovery, depending on severity and duration of a VLOS.

The selection of Alternative III or IV (coastwise corridor deferrals), which removes parts of LAs 8-13 from the Lease Sale area, could reduce the chance of a VLOs from contaminating nearshore, estuarine, intertidal, and riverine waters. The larger deferral associated with Alternative III has greater potential to reduce onshore and nearshore impacts as compared with Alternative IV. The effects of degradation of offshore water quality would not be reduced under either Alternative III or IV.

IV.E.14. Economy

This section discusses the phase by phase effects of the potential impacts on the economy from a hypothetical VLOS. This section focuses on the impacts to jobs, personal income, revenues, and potential future economic activity. Each phase is evaluated according to the impact producing factors described in the hypothetical scenario that could affect the economy. The highest potential for impacts to the economy would occur during Phase 4, when thousands of spill response and cleanup workers would be employed. Revenues to the North Slope Borough, State of Alaska, and the Federal government could also be affected by a VLOS event.

Phase 1 (Initial Event)

In Phase 1, the potential impact producing factors with relevance to the economy include explosion and fire. Once the explosion is reported, response equipment and workers will be mobilized and sent to the site of explosion to address a fire. There could also be economic impacts from psychological/social distress from news and images of the event. Employment and personal income levels will be moderate during this initial phase.

Phase 2 (Offshore Oil)

In Phase 2, the relevant impact producing factors for the economy include contact with oil, contamination, and loss of access. There could be increasing space/use conflicts for access to and use of shipping lanes, open water space, open air space, and dock/port space. Employment and personal income would begin to rapidly increase during the continuing release of an oil spill in offshore waters as response workers and equipment continued to mobilize and first responders began offshore cleanup operations. The numbers of cleanup workers and response vessels in Phase 2 would depend on the spatial extent of the thin liquid layer of oil on the water surface. The effects of spill response and cleanup activities on the economy are described in greater detail within Phase 4.

Phase 3 (Onshore Oil)

The important impact producing factors for the economy in Phase 3 include contact with oil, contamination, and loss of access from increased space/use conflicts from water traffic as well as dock space. The numbers of workers and onshore infrastructure would begin to substantially increase during this phase as more workers are needed for onshore cleanup operations. The effects of spill response and cleanup activities on the economy are described in greater detail within Phase 4.

Phase 4 (Spill Response and Cleanup)

Potential impact producing factors in Phase 4 that will generate substantial economic effects include vessels, aircraft, in-situ burning, animal rescue, dispersants, skimmers, booming, beach cleaning, drilling of relief well, and bioremediation. Employment and personal income will reach peak levels during Phase 4. In this phase, thousands of workers would be employed for response and cleanup operations in offshore federal and state waters, as well as onshore federal, state, and private lands. Additional housing and infrastructure may be needed to support the influx of a large amount of workers for spill cleanup, generating additional property tax revenues for the NSB.

The discussion of employment for oil spill response 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 of up to 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. During the EVOS, 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 likely be located in existing enclave-support facilities, though local residents leaving their jobs to work on the cleanup could create labor shortages in the local economy. Additional housing and infrastructure could be needed to support the influx of a large amount of workers for spill cleanup, with extra ships staged offshore likely needed to house spill response workers and infrastructure. The NSB would presumably receive property tax revenues from any additional onshore infrastructure put in place to support clean up efforts. We assume that additional infrastructure built onshore would also be an enclave.

In the event of a 2.2 MMbbl oil spill, the number of workers employed to clean it up would depend on several factors. These include the procedures called for in the OSRP, 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. If a very large oil spill of 2.2 MMbbl occurred it would generate several thousand direct, indirect, and induced jobs and millions of dollars in personal income associated with oil spill response and cleanup. The number of workers would likely be much larger than the number of workers who cleaned up the EVOS. For further detail on the spill response and cleanup components of the VLOS scenario, see Section IV.D.2. Any potential moratoria subsequent to a hypothetical VLOS would have a negative effect on jobs, income, and revenues generated by other potential future production on state and federal lands and waters.

The number of vessels and responders would increase exponentially as the spill continued, peaking in Phase 4. See section IV.D.2 has assumptions on number of staging locations, vessels, workers, and booming teams involved in response. For a discussion on how seasonal conditions could affect response and cleanup activities, see Section IV.D.2. the assumption is that while employment during winter cleanup and response would be less than employment for summer cleanup and response operations, the overall short run employment effect would be substantial.

Revenue impacts on the NSB from a potential very large oil spill would be in the form of property tax revenues from any new infrastructure built to house the influx of workers and infrastructure. If TAPS throughout is reduced because of the oil spill, either through a moratoria or space-use conflicts with producing fields, direct revenues accruing to the State would be adversely affected, as would indirect revenues associated with full pipeline enhanced value from North Slope production. Any other displaced or lost production from Federal offshore or onshore leases would reduce revenues the Federal government receives through oil and gas production. Potential space/use conflicts or a moratorium could also delay permitting for other exploration and production activities that would generate economic activity through employment, personal income, and revenues. Loss of access from congested shipping routes and crowded ports could have a short term affect on Alaska economic output as delivery of goods and services could be reduced.

Phase 5 (Long-term Recovery)

In Phase 5, the impact producing factors with relevance to the economy are unavailability of environmental resources, contamination, perception of contamination (tainting), co-opting of human resources, and psychological distress. Each of these impact producing factors has the potential to have long term economic impacts in the form of employment, personal income, and revenues. In Phase 5, response and cleanup employment will begin declining from peak levels.

A VLOS event could displace future economic activity that currently does not exist or is relatively minor in the Arctic. A VLOS could have substantial effects on jobs and revenues associated with any future commercial or recreational fishing taking place in the area, either from pollution of the fishing resource or closure of fishing grounds, and potential space/use conflicts between fisherman and response and cleanup operations. A VLOS could have similar adverse impacts on jobs and revenues generated by potential tourism and marine shipping in the region.

A VLOS event would also result in a Natural Resource Damage Assessment (NRDA). The National Ocean and Atmospheric Administration (NOAA) conducts NRDA’s through a process that includes determination of the injuries from a spill, quantification of those injuries, and then restoration planning. For a description of the approaches and methods NOAA uses to identify and value injuries to natural resource services that have been damaged from an event like a VLOS, please refer to NOAA’s Damage Assessment, Remediation, and Restoration Program (http://darrp.noaa.gov/about/index.html). The result of the NRDA process could be substantial revenue impacts as the population of interest is compensated for a range of natural resource service values damaged by the hypothetical VLOS and could come at a high cost to the responsible parties. For example, after the EVOS, Exxon paid Federal and state governments $900 million for civil claims, and an additional $125 million in restitution and fines under a separate settlement for Federal criminal charges.

Oil Spill Trajectory Analysis

Above we have addressed the potential impacts to the economy during each phase of a VLOS event. In terms of oil spill impacts, the trajectory analysis for economic impacts is not expected to be different for a VLOS regardless of which launch area it emanates from or the percentage of spill trajectories contacting particular environmental resource areas. Future potential economic activities that are contacted would depend on where those activities are taking place; estimating where highly speculative future economic activity that does not exist now could take place during the time frame of the hypothetical scenario is beyond the scope of this analysis.

Conclusion

A VLOS event of 2.2 MMbbl would generate several thousand direct, indirect, and induced jobs, and millions of dollars in personal income associated with oil spill response and cleanup in the short run. The effects would be significant in the short term. The expectation is that employment of cleanup workers to increase rapidly during Phase 2 and Phase 3, and to peak during Phase 4. Revenue impacts from a VLOS event include additional property tax revenues accruing to NSB from any additional onshore oil spill response infrastructure, and any potential decline in Federal, State, and local government revenues from displacement of other oil and gas production. A VLOS could also have significant adverse impacts on economic activity that does not currently take place in the area but could exist in the future, such as commercial fishing, recreational fishing, tourism, and increased Arctic marine shipping. The above impacts would occur to the same extent under each action alternative.

IV.E.15. Subsistence Harvest Patterns

A very large oil spill (VLOS) could affect subsistence-harvest patterns through altering the overall subsistence round due to: (1) displacement, (2) undesirability for use from contamination or perceived tainting, (3) reduced numbers due to species deflection from oil or anthropogenic noise during remediation efforts, or their pursuit becoming more difficult because of increased hunter effort, and (4) increased risk or cost of the subsistence effort due to having to travel further distances to harvest species. Direct contact of oil with barrier islands and coastal shorelines would create toxic environments for resources and traditional subsistence harvests in these areas. The effects on subsistence resources are provided in the discussions in the previous sections. The Sale 193 FEIS includes broader discussion of the types of impacts that could occur to subsistence-harvest patterns, and provides background information for the assessment below. The importance of this issue to local residents is difficult to summarize. The following testimony is instructive:

> I also want to add that the unseen is a mystery to all of us. That mystery is our ocean. We only take what it gives us. We only take what it gives us. The animals give themselves to us to provide for us. So we take as much as it gives us. If anything should happen, we won’t have anything. I’m afraid of that. We won’t have anything. (Ms. Lillian A. Lane, Pt. Hope, Alaska, June 22, 2011)

A VLOS in winter could affect polar bear hunting and sealing. Bird hunting, sealing, whaling, and the ocean netting of fish could be affected by a spill during the open-water season. Disturbance could extend the subsistence hunt in terms of miles to be covered, making more frequent and longer trips necessary to harvest enough resources in a harvest season. The loss of waterfowl populations to oil spills would cause harvest disruptions in the spring that would be significant to subsistence hunters who regard the spring waterfowl hunt to be of primary importance. In the event of a VLOS contacting and extensively oiling habitats, the presence of hundreds of humans, boats, and aircraft would result in anthropogenic noise that would likely displace subsistence species and alter or reduce subsistence-hunter access to subsistence species in traditional harvest areas.

Negative effects on 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. In the Chukchi Sea region, marine mammals are the most important subsistence resource, both culturally as well as in terms of food. The bowhead whale hunt could be disrupted, as could the hunts for beluga whale, bearded seal, and other marine mammals generally. Impacts would be intensified should entrained oil contaminate ice leads and surrounding shoreline. Although there has been little harvest of walrus in Wainwright and Point Lay in the past few years, future harvest could be disrupted. Animals could be directly oiled, or oil could become part of the ice floes 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. It is often stated in public testimony that “The sea is my garden.” A VLOS 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 (see Sections IV.E.5, Fish Resources; IV.E.12, Terrestrial Mammals; and IV.E.9, Marine and Coastal Birds, respectively).

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 on some bird populations. A potential loss of a small number of polar bears would reduce their local availability to subsistence users. Oil-spill-cleanup activities could produce additional effects on subsistence activities, potentially causing displacement of subsistence resources and subsistence hunters.

Although the VLOS would originate within the Chukchi Sea Planning Area, 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 Inupiaq 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 the Chukchi Sea. Concerns about contaminated subsistence 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.

In the Chukchi Sea the active-ice, or ice-flaw, zone is an important habitat for marine mammals such as bowhead and beluga whales, walruses, seals, and other marine mammals. Seals, walruses, and beluga whales would be most vulnerable to a spill contacting this zone; polar bears would be most vulnerable to spills contacting the flaw zone or the coast. 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 (USDOI, MMS, 2007a). For more information on potential impacts from a VLOS to these species, see Sections IV.E.10 Ice Seals; IV.E.11 Pacific Walrus; IV.E.8 Polar Bear; and IV.E.7 Cetaceans.

Very large oil 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 (Figure 16) harvested in the traditional fashion (USDOI BLM and MMS, 2003; USDOI, BLM, 2004a, 2005, 2006; USDOI, MMS, 1987b, 1990b, 1998a, 2001, 2003a, 2004, 2006a,b,d).

Effects of a VLOS on subsistence-harvest patterns are discussed below for each of the five phases of the hypothetical scenario. The greatest potential for effects on subsistence resources and practices occurs during Phase 3 (Onshore Contact) and 4 (Spill Response and Cleanup). In all cases, long-term recovery of resources and practices is likely, and harvesting, sharing, and processing of subsistence resources would continue but would be hampered to the degree these resources were contaminated. Tainting concerns in communities nearest the spill or contacted coastlines could seriously curtail traditional practices for harvesting, sharing, and processing resources and threaten pivotal practices of traditional Native culture. In the case of long term or extended contamination, harvests would cease until such time as local subsistence hunters perceived resources as safe. Any losses of resources could be significant to the local harvest by subsistence-dependant communities. Just as with the Exxon Valdez oil spill, the instantaneous nature and the magnitude of the event would not permit opportunistic “stocking up” of available resources (USDOI, MMS, 2007a, 2008a).

Figure 16. Subsistence foods packaged for consumption, Point Hope, Alaska (June 21, 2011).

Phase 1 (Initial Event)

Direct impacts on subsistence resources would likely be quite localized in the initial phases of the blowout event. However, indirect impacts to substance-harvest patterns from news and images of the event would likely be traumatic to subsistence harvesters throughout the Chukchi Sea region, and would likely produce increased stress and anxiety over the safety and availability of resources and harvest areas. Fears about reduced or contaminated resources, contaminated habitats and harvest areas, reductions in the ability to harvest traditional foods, and general food safety could all cause additive social stress (USDOI, MMS, 2007a, 2008a).

Phase 2 (Offshore Oil)

In this phase, offshore resources could come into direct contact with spilled oil, and pollution stemming from an oil spill may contaminate environmental resources, habitat, and food sources. The presence of oil and the initial response to the spill event could prevent or disrupt access to and use of affected areas. If offshore oil directly contacted migrating or resident marine mammals and compromised traditional harvest areas by persisting there, subsistence practices, particularly bowhead whaling, would be seriously curtailed due to the same issues concerning contamination discussed in Phase 1, as well as creating serious reductions in access to traditional nearshore harvest areas. Seabirds and waterfowl would be most vulnerable to this phase of a VLOS because they spend the majority of their time on the sea surface and often aggregate in dense flocks. Marine mammals such as ice seals, bearded seal, walrus and polar bear would either not be in the area or, in the case of walrus, would be unlikely to remain in the vicinity of an active drilling operation (see Sections IV.E.8, IV.E.10, and IV.E.11).

Effects of a VLOS on key subsistence species during Phase 2 are discussed below.

Bowhead Whales. In the event of aVLOS, the probability of oil contacting whales is likely to be considerably less than the probability of oil contacting bowhead habitat and traditional harvest areas. 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, some portion of the population could be exposed to spilled oil. Prolonged exposure to freshly spilled oil could kill some whales. Whales travelling under the ice or feeding near the bottom could also experience contamination. A recent study establishing that bowhead whales have olfactory bulbs and can smell when they breathe tends to substantiate TEK regarding this species' ability to smell and avoid areas where oil is present. For more information on potential impacts to bowheads from a VLOS, refer to Section IV.E.6.

There are, in some years and in some locations, relatively large aggregations of feeding bowhead whales within potentially affected areas. 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. 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. Traditional practices for harvesting, sharing, and processing subsistence resources could be seriously curtailed in the short term, if there are concerns over the tainting of bowhead whales or their feeding areas from an oil spill.

Barrow elder Thomas Brower, Sr., observed an oil spill from a U.S. Navy vessel in the Plover Islands east of Barrow in 1944 (Brower, 1944 as cited in NSB, Commission on History and Culture, 1980) where about 25,000 gallons were spilled. According to Brower:

> …for four (4) years after that oil spill, the whales made a wide detour out to sea from these islands. Those Native families could no longer hunt whales during these years at that location."

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.

Thomas Brower, Sr. also stated that:

> In the cold, Arctic water, the oil formed a mass several inches thick on top of the water. Both sides of the barrier islands in that area(the Plover Islands) became covered with oil. That first year, I saw a solid mass of oil six (6) to ten (10) inches thick surrounding the islands. On the seaward side of the

> islands, a mass of thick oil extended out sixty (60) feet from the islands, and the oil slick went much further offshore than that. I observed how seals and birds who swam in the water would be blinded and suffocated by contact with the oil. It took approximately four (4) years for the oil to finally disappear. (Brower as cited in NSB, Commission on History and Culture, 1980) (USDOI, MMS, 2007a)

Beluga Whales, Seals and Walrus. The effects from a VLOS on beluga whales, seals, and walrus would occur from: (1) oiling of skin and fur; (2) inhaling hydrocarbon vapors; (3) ingesting oil-contaminated prey; (5) losing food sources; and (6) temporary displacement from some feeding areas. Additional discussion of potential impacts to these marine mammals is provided in Section IV.E.10. In general, any VLOS in nearshore marine waters could cause injury or death to these sea mammals, potentially cause them to move off of their normal course, and make them unavailable for the subsistence harvest.

A VLOS contacting nearshore areas near Point Lay would disrupt the beluga migration and deprive the community of its primary subsistence hunt. There are, in some years and in some locations, relatively large aggregations of feeding and molting beluga 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. 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 (USDOI, MMS, 2007a). Analysis of potential VLOS impacts on these species is provided in Section IV.E.7 Cetaceans, Section IV.E.10 Ice Seals, and IV.E.11 Pacific Walrus

Polar Bears. If a VLOS occurred, significant impacts 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 and rapid loss of sea ice habitat due to global climate change. Analysis of potential VLOS impacts to Polar Bears is provided in Section IV.E.8.

Birds. The direct and indirect effects on marine and coastal birds from contact with oil are analyzed in greater detail in Section IV.E.9. Many bird species important to subsistence in the Chukchi Sea region are associated with nearshore and coastal areas, or both. Impacts to subsistence caused by oiling of birds during the offshore spill phase are presented within the Phase 3 discussion of onshore contact, below.

Phase 3 (Onshore Contact)

In this phase the more profound impacts to subsistence resources and practices would occur: (1) onshore resources and coastal harvest areas could come into direct contact with spilled oil; (2) pollution stemming from a VLOS contaminate subsistence resources and their habitats and food sources, subsistence harvest areas, and seriously curtail use of traditional food sources because of actual and perceived contamination. In addition, the presence of oil would prevent or disrupt access to and use of traditional subsistence harvest areas. For subsistence practices to fully recover, access to recovered/restored harvest areas would be necessary.

Effects of a VLOS on key subsistence species during Phase 3 are discussed below.

Walrus and Polar Bears. For walrus, an oil spill impacting coastal haulout areas could have a significant impact on walrus populations; the same would be true if oil contacted denning polar bears. Oil-spill effects could cause injury or death to these sea mammals, potentially cause them to alter normal behaviors, and make them unavailable for the subsistence harvest (see Sections IV.E.11 and IV.E.8 for analysis of potential impacts on these species).

Caribou and Other Terrestrial Mammals. Terrestrial mammals would be affected by a VLOS to the extent they reside in coastal habitats and feed near contaminated shorelines. Caribou can frequent barrier islands and shallow coastal waters during periods of heavy insect harassment and could become oiled and/or eat contaminated vegetation, although more likely animals would be deflected from contaminated areas by spill cleanup activity. During late winter- early spring, caribou move out on to the ice and lick sea ice for the salt and would be exposed to oil if a spill contaminates the ice. If a VLOS occurred during the open-water season or during winter and melted out of the ice during spring, caribou frequenting coastal habitats would be directly contaminated by the spill along the beaches and in shallow waters during periods of insect-pest-escape activities. Caribou that become oiled are not likely to suffer the loss of thermoinsulation through fur contamination although toxic oil would be absorbed through the skin and also would 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 a VLOS 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 bears and foxes through kidney failure and other complications. Small numbers of grizzly bears and Arctic foxes could be lost through ingestion of contaminated prey or carrion (USDOI, MMS, 2007a) (see Section IV.E.12 for analysis of potential impacts on these species).

Fish. A VLOS 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. Anadromous fish can be particularly impacted if oil reaches mouths and deltas of anadromous streams and rivers. Table 7 within Section IV.E.5 provides more detailed information on anadromous waters in the region, and the species that they support. Depending on the timing, extent, and persistence of a VLOS, 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 harvests for many years.

Birds. As described in Section IV.E.9, the greatest potential for substantial adverse impacts from a VLOS on marine and coastal birds would come in important coastal bird habitats. These areas are Kasegaluk Lagoon, Peard Bay, the 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 VLOS 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, 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. The loss of waterfowl populations to oil spills would cause harvest disruptions that would be significant to subsistence hunters who regard the spring waterfowl hunt to be of primary importance.

Subsistence Practices. A VLOS 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 would reduce the amount of subsistence foods harvested, result in changes in traditional diets, and increase risks and wear and tear on equipment as users would be forced to travel farther to obtain subsistence resources. Marine mammals are the most important subsistence resource, both conceptually and as food, for these regions. The bowhead whale hunt could be disrupted, as could the beluga harvest and the more general and longer hunt for walruses. Animals could be directly oiled, or oil could contaminate the icefloes they use on their northern migration. Contaminated animals would be considered undesirable and could be more difficult to hunt because of the physical conditions. Animals could be "spooked" and wary, either because of the spill itself or of the "hazing" of marine mammals, which is a standard spill-response technique used 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 up a spill of this type in a timely manner (USDOI, MMS, 2007a).

In addition to impacts to subsistence-resource populations, a VLOS 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 would make 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 would continue (USDOI, MMS, 2007a).

While the greatest tainting concern is most typically expressed as it relates to potential oil-spill effects whales and whaling, it is also a more generalized concern for marine mammals and ocean resources. Marine mammals and fish typically comprise 60% of a coastal community's diet, it is frequently stated in public testimony that "The sea is my garden." A VLOS could impact migrating anadromous fish in the river deltas, as well as species that use (potentially oiled) coastal and nearshore habitats, such as nesting birds and breeding caribou. Concerns about tainting also would apply to walrus, bearded seal, other seals and polar bears and would cause serious adverse effects on some bird populations. A potential loss of a small number of polar bears would reduce their local availability to subsistence users. Waterfowl, fish, and marine mammals could be fouled, contaminated, or killed. A VLOS 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 and bears, also could be harmed (USDOI, MMS, 2007a).

Oil-spill-cleanup activities would produce additional effects on subsistence activities, potentially causing displacement of subsistence resources and subsistence hunters. Even if, in some cases, biological effects on subsistence resources did not affect species' distributions or populations, disturbance could extend the subsistence hunt in terms of miles to be covered, making more frequent and longer trips necessary to harvest enough resources in a harvest season. Major negative impacts 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 Exxon Valdez oil spill event and the subsequent cleanup effort.

A spill originating within the Chukchi Sea region would produce indirect impacts felt by communities remote from the sale area and far removed from the spill. Essentially, these same concerns about the integrity of subsistence resources, subsistence harvests, and subsistence food consumption would be shared by all Iñupiat and Yup'ik Eskimo communities in the Chukchi Sea Region and would include indigenous people on the Russian Chukchi Sea coast adjacent to the migratory corridor used by whales and other migrating species including salmon stocks breeding in the Bering Sea region (USDOI, MMS, 2007a).

There is also concern that the International Whaling Commission, which sets the quota for the Iñupiat subsistence harvest of bowhead whales, would reduce the harvest quota following a major oil spill to ensure that overall population mortality did not increase. Such a move would have profound cultural and nutritional impacts 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 oil-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, Iñupiat 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 (USDOI, MMS, 2007a).

Russian Arctic Chukchi Sea Coastal Communities. Depending on the location and trajectory of the hypothetical VLOS, coastal communities on the Russian side of the Chukchi Sea could also experience adverse impacts to their subsistence-harvest patters. Potentially, important coastal lagoons and nearshore subsistence-harvest areas for beluga, gray and bowhead whales, walrus, seals, fish, and birds could be contacted in the event of a VLOS. 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 lead 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 VLOS could exacerbate existing stresses on local resource populations and the local hunt, causing significant impacts to indigenous coastal communities (Newell, 2004; Nuttall, 2005).

Phase 4 (Spill Response and Cleanup)

In this phase the more profound impacts to subsistence resources and practices would occur from noise disturbances, habitat alteration, and the real and perceived contamination from: (1) vessels supporting response and cleanup efforts; (2) aircraft supporting response and cleanup efforts; (3) relief well drilling, (4) in-situ burning of spilled oil; (5) the hazing and capture of wildlife; (6) dispersant use; (7) bioremediation; and, (8) beaching cleaning. In addition, manpower reallocations could seriously threaten traditional subsistence practices. Spill cleanup would provide an opportunity for local high paying spill cleanup wage work and would likely displace many local hunters and equipment from traditional subsistence harvest pursuits. Cleanup for a very large onshore oil spill could disrupt subsistence-harvest activities for at least an entire season from oil-spill employment for oil-spill response and cleanup. Effects of a VLOS on key subsistence species and harvest practices are discussed below (USDOI, MMS, 2007a).

Disturbance to bowhead and beluga whales, seals, polar bears, caribou, fishes, and birds potentially would increase from oil-spill-cleanup activities. Offshore, skimmers, workboats, barges, aircraft overflights, relief well drilling activities and in-situ burning during cleanup could cause whales to temporarily alter their swimming direction. Such displacement could cause some animals, including seals in ice-covered or broken-ice conditions, to avoid areas where they are normally harvested or to become more wary and difficult to harvest. Nearshore, workers and boats, and onshore, workers, support vehicles, heavy equipment, and the intentional hazing and capture of animals could disturb coastal resource habitat, displace subsistence species, alter or reduce subsistence hunter access to these species, and alter or extend the normal subsistence hunt. Overall, oil-spill-cleanup activities, far from providing mitigation, more likely should be viewed as an additional impact, potentially causing displacement of subsistence resources and subsistence hunters (see Impact Assessment, Inc., 1998). Please also refer to Section IV.E.7, Cetaceans.

Effects of a VLOS on key subsistence species during Phase 4 are discussed below.

Bowhead Whales. 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 temporary displacement. Oil-spill-response activities that included active attempts to move whales away from oiled areas would cause short-term changes in local distribution and abundance. In the case of a winter spill, few, if any, bowhead whales would be present and that action of ice in the lead system would reduce the amount of volatile hydrocarbons inhaled by bowheads (USDOI, MMS, 2002; USDOI, MMS, 2003a).

Beluga Whales, Walrus and Other Marine Mammals. In the case of a VLOS in winter, when few important subsistence marine mammal resources would be present, cleanup measures would tend to reduce potential before migrating whales and other marine mammal 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 some seal pup losses. If a VLOS 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 walruses and to contribute to increased stress and reduced pup survival of ringed seals, if operations occur during the spring and as long thereafter as cleanup efforts continue (Impact Assessment, Inc., 1998; USDOI, MMS, 2003a, USDOI, BLM 2004a, b).

Polar Bears. If a VLOS 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 some bear cubs. These effects would occur for the duration of cleanup. Cleanup efforts would include the removal of all oiled animal carcasses to prevent polar bears from scavenging them. Aircraft hazing of wildlife away from the spill would reduce the chances of polar bears entering coastal waters where there is an oil slick (Impact Assessment, Inc., 1998; USDOI, MMS, 2003a, USDOI, BLM, 2004a, b).

Caribou and Other Terrestrial Mammals. If aVLOS 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. These effects would occur for the duration of cleanup operations and are not expected to significantly affect caribou herd movements or foraging activities. Cleanup also would disturb some muskoxen, grizzly bears, and Arctic foxes (USDOI, BLM, 2006; USDOI, MMS, 2003a).

Fish. Oil-spill-cleanup activities in open water or in broken ice are not expected to adversely affect fish populations utilized for subsistence. Onshore cleanup is likely to add little to the toxic oil contact impacts to fish resources described above (USDOI, MMS, 2003a).

Birds. Spill response activities could disturb and displace marine and coastal birds, which could have net beneficial effects by intentionally or unintentionally moving birds away from oiled areas. This displacement may move birds to unoiled areas, with negligible energetic costs, if these habitats were of similar quality. Marine and coastal birds could be harmed, however, if birds moved to inferior habitats where biological needs could not be met. Several species have specific nesting (e.g., islands, cliffs, low-gradient beaches) or foraging requirements (e.g., lagoons, passes between barrier islands) that could be altered by clean-up efforts. While the marine and coastal birds could physically relocate to other areas, those areas may be unsuitable and delay recovery.

Subsistence Practices. 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, walruses, 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 VLOS and spill-response activities, would persist beyond the timeframe of a single season, perhaps lasting several years (USDOI, MMS, 2007a). 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, as well). 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 as they would likely persist for more than a single harvest season (Impact Assessment, Inc., 1998; USDOI, MMS, 2003a, USDOI, BLM, 2004a, b).

Phase 5 (Long-term Recovery)

In this phase the impacts to subsistence resources and practices would occur from: (1) the unavailability of (or increased difficulty in utilizing) environmental resources; (2) longer term contamination from pollution stemming from the oil spill; (3) the perception that resources are contaminated altering use patterns; (4) the co-opting of human resources such as manpower, equipment, and other resources required to study long-term impacts and facilitate recovery would be unavailable for other purposes; and (5) psychological and social distress, stemming from long-term impacts from a VLOS. Effects of a VLOS on key subsistence species and harvest practices are discussed below.

In the long-term recovery phase, longer term subsistence impacts would transform into near-term sociocultural impacts and their disaggregation would be difficult. Nevertheless, many observations can be posited, based on long-term recovery research done after the Exxon Valdez oil spill. Long-term subsistence impacts from a VLOS and its cleanup would be any perceived chronic disruption of the bowhead whale harvest and any actual or perceived tainting of the whale meat anywhere during the bowhead whale inmigration, summer feeding, and outmigration. Adverse subsistence effects that would be in evidence in the recovery period would include long-term disruptions in harvest patterns that could lead to a breakdown of kinship networks and sharing patterns and increased social stress in the community (USDOI, MMS, 2007a).

Participation in oil-spill cleanup would be such a disruption. Cleanup participation, as local residents did in the Exxon Valdez oil spill in 1989, could cause residents to: (1) not participate in subsistence activities; (2) have a surplus of cash to spend on material goods as well as drugs and alcohol; and (3) not seek or continue employment in other jobs in the community (as oil-spill-cleanup wages are higher than average). Indications are that the sudden, dramatic increase in income earned from working on cleaning up the Exxon Valdez spill and being unable to pursue subsistence harvests because of the spill caused a tremendous amount of social upheaval. This was revealed by reported increases in depression, violence, and substance abuse (Picou et al., 1992; Cohen, 1993; Picou and Gill, 1993; Fall, 1992; Impact Assessment, Inc., 1990c; Fall and Utermohle, 1995; Human Relations Area Files, Inc., 1994a, b, c).

Multiyear disruptions of subsistence-harvest patterns, especially to the bowhead whale, a pivotal subsistence resource to the Iñupiat culture, could disrupt sharing networks, subsistence-task groups, and crew structures and would cause disruptions of the central Iñupiat cultural value: subsistence as a way of life. These disruptions also could cause a breakdown in sharing patterns, family ties, and the community's sense of well-being and could damage sharing linkages with other communities. Other effects might be a decreasing emphasis on subsistence as a livelihood, with an increased emphasis on wage employment, individualism, and entrepreneurism. If a VLOS occurred, employment for oil-spill response and cleanup could disrupt subsistence-harvest activities for at least two harvest seasons. If a VLOS adversely impacted traditional-use areas, subsistence users would have to travel farther to harvest uncontaminated resources, which would result in higher effects on sociocultural patterns for a much longer time than the actual period that subsistence resources would be measurably contaminated. In general, 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, and extra-regional efforts to acquire subsistence foods would by necessity be undertaken, likely taxing the resources of other subsistence regions (USDOI, MMS, 2007a, 2008a).

Research of the long-term effects of the Exxon Valdez oil spill in 1989 (Fall et al., 2001; Impact Assessment, Inc., 2001) indicates the following effects may be realized from a VLOS on communities whose cultural survival is tied to the traditional use of food: (1) communities highly dependent on subsistence (“wild”) foods are most vulnerable to the effects from an oil spill. In these communities, self-identities and family life are organized to a larger extent around seasonal harvest distribution and use of foods; (3) the lingering presence of oil in the environment leads to continuing avoidance of subsistence-harvest resources; (4) the short-term depression of subsistence-food harvests and uses did not lead to long-term sociocultural losses, such as loss of cultural knowledge, skills, or values within families; (5) the organization of the subsistence sector was not eroded by the spill; and (6) concerns over contamination of subsistence resources persists, and confidence in the benefits in eating natural foods was eroded.

An overall study on 21 Alaskan communities concluded that impacts from the EVOS on subsistence use and the social and cultural system that subsistence activities support persist to this day (Fall and Utermohle, 1995; Impact Assessment, Inc., 1998; Field et al., 1999; USDOI, MMS, 2003a; USDOI, BLM and MMS, 2003). Impacts in the first year following the spill included dramatic declines in harvest levels, reduced diversity of resources used, reduced sharing, and disruption in opportunity for young people to participate and learn the cultural values associated with subsistence. Fear of contamination of food resources was identified as a major factor in these reductions. In the following 3 years, harvest levels, sharing, and subsistence involvement rebounded, although not uniformly across and among communities. Ten years after the spill, the authors conclude that subsistence uses largely had recovered to previous levels, but that some long-term changes remained, notably in fish species making up a larger portion of total subsistence, with marine mammals, marine invertebrates and birds making up a smaller part than before the spill. Resource scarcity was cited as main the reason for changes rather than fear of contamination that was cited just after the spill. Hunters also reported that additional effort was required to achieve desired harvest levels because some resources were more scarce (Fall and Utermohle, 1999).

After a VLOS, it is expected that considerable stress and anxiety would occur over the loss of subsistence resources, contamination of habitat and subsistence resources, fear of the health effects of eating contaminated wild foods, fear of changes to harvest regulations (i.e., quotas), and the need to depend on the knowledge of others about environmental contamination (Fall 1992, McMullen 1993). Individuals and communities would be increasingly stressed during the time it would take to modify subsistence-harvest patterns by selectively changing harvest areas (if such areas were even available) and there would be increased costs and risks associated with travel and hunting in unfamiliar areas. Associated cultural activities, such as the organization of subsistence activities among kinship groups and the relationships among those who customarily process and share subsistence harvests, would also be modified or would decline (USDOI, BLM, 2008).

Oil Spill Trajectory Analysis

Above we have addressed the potential impacts to subsistence resources and harvests during each phase of the hypothetical scenario. We now use estimated results (expressed as percentage of trajectories contacting) provided by the OSRA model to consider whether such impacts could occur.

This section describes the results estimated by the OSRA model of a hypothetical very large oil spill in the Chukchi Sea contacting specific Environmental Resource Areas (ERAs) and Land Segments (LSs) that are important for subsistence resource concentrations or important as traditional harvest areas. An ERA is a hypothetical polygon that represents a geographic area important to subsistence resource species' use or subsistence harvests within a specific season. The ERA locations are incorporated from Appendix A of the Sale 193 FEIS (USDOI, MMS 2007a) and shown in Appendix B, Figures B-1 to B-4. The ERAs important to subsistence-harvest patterns are summarized in Appendix A, Table A.1-15 of the Sale 193 FEIS. The vulnerability of an ERA is based on the seasonal use patterns of subsistence resources or the seasonal of subsistence harvesters using the area (Appendix A, Table A.1-12, USDOI, MMS 2007a).

The following discussion presents the results (expressed as a percentage of trajectories contacting) estimated by the OSRA model of a hypothetical very large spill contacting ERAs and LS habitats that are important for subsistence resources and harvests. Given the numbers of resources and the large nearshore marine harvest areas of the Chukchi Sea subsistence-dependent coastal communities of Barrow, Wainwright, Point Lay and Point Hope, as well as those on the Russian Chukotkan coast, it is likely that many of these areas would be contacted by a very large spill. The hypothetical very large spill could contact many of these areas and avoid others entirely, depending on the location of the spill and location of the ERA or a specific LS at the time of the spill.

Oil-spill contact in winter could affect polar bear hunting and sealing. During the open-water season, a VLOS 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 results located in Appendix B, Tables B-7, B-8, B-9, B-10, B-13 and B-14 in the first paragraph and then winter results located in Appendix B, Tables B-15, B-16, B-17, B-18, B-21and B-22 in the second paragraph. Maps showing the ERA, LS and BS locations discussed are located in Appendix B; ERAs (Figures B-2 to B-5), LSs (Figures B-6 to B-8), and BSs (Figure B-1).

Barrow. For a summer spill, the OSRA model estimates <0.5% of spill trajectories from LA1-LA13 contacting ERA 41 (Barrow Chukchi Sea whaling and subsistence area) within 60 days, and <0.5-1% trajectories contact from LA1-LA13 within 360 days; for ERA 42 (Barrow Beaufort Sea whaling and subsistence) there is <0.5-12% trajectories contacting within 60 days, and <0.5-14% trajectories contacting from LA1-LA13 within 360 days. The LSs 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 <0.5-11% trajectories contacting from LA1-LA13 within 60 days and a <0.5-13% trajectories within 360 days (LS 90 is <0.5%).

Winter-trajectory percentages generally are higher. Within 60 days, they range from <0.5-5% starting at LA1-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. Land Segments 82-85 have a <0.5-3% trajectories contacting within 60 days from LA1-LA13; LSs 82-88 have a <0.5-7% trajectories contacting within 360 days from LA1-LA13.

Wainwright. For a summer spill, the OSRA model estimates <0.5-27% trajectories starting at LA4-LA13 contact Wainwright's subsistence ERA 40 within 60 days and 1-29% trajectories contact from LA1-LA13 within 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 <0.5-6% trajectories contacting from LA11-LA13 within 60 days and 360 days.

In winter, percentage of trajectories contacting, range from <0.5-14% from LA4-LA13 for ERA 40, and 1-20% within 360 days from LA1-LA13. The LSs 78-80 have <0.5-2% trajectories contacting within 60 days from LA12 (LS 81 has values <0.5%). Land Segments 76-80 have a <0.5-4% trajectories contacting within 360 days from LA4-L13.

Point Lay. For a summer spill, the OSRA model estimates <0.5-16% trajectories from LA4-LA13 contact Point Lay's subsistence ERA 39 within 60 days and <0.5-19% trajectories contacting from LA4-LA13 within 360 days. Land Segments 70 (Kuchaurak/Kuchiak Creek), 71 (Kukpowruk River/Sitkok Point), 72 (Point Lay/Siksrikpak Point), 73 (Tungaich Point/Tungak Creek), 74 (Kasegaluk Lagoon/Solivik Island), and 75 (Akeonik, Icy Cape) have <0.5-4% trajectories contacting from LA4-LA12 within 60 and 360 days.

In winter, contact percentages within 60 days, range from <0.5-20% trajectories from LA4-LA11 for ERA 39, and <0.5-25% within 360 days from LA1-LA12. Land Segments 71-75 have <0.5-4% trajectories contacting within 60 days from LA4-LA11. Land Segments 70-75 have <0.5-5% trajectories contacting within 360 days from LA4-LA12.

Point Hope. For a summer spill, the OSRA model estimates <0.5-8% trajectories from LA4-LA11 contact Point Hope's subsistence ERA 38 within 60 days, and <0.5-8% trajectories contacting from LA4-LA11 over a 360-day period. Land Segments 63 (Tasikpak Lagoon/Cape Seppings), 64 (Kukpuk River/Point Hope), 65 (Buckland/Cape Lisburne), and 66 (Ayugatak Lagoon) have <0.5-3% trajectories contacting from trajectories from LA4-LA11 within 60 and 360 days (LS 62, Atosik Lagoon/Kuropak Creek, has values <0.5%).

In winter, the only contact percentages for ERA 38 greater than 0.5% within 60 and 360 days are 1-2% from LA9-LA10. Point Hope LSs 62-64 and 66 all have a <0.5% trajectories contacting within 60 days from LA1-LA13 with LS 60 having 1% trajectories contacting. Land Segments 64 and 65 have a 1% trajectories contacting within 360 days from LA9. Within 360 days, LSs 62, 63, and 66 all have <0.5% trajectories contacting.

Kivalina. For a summer spill, the OSRA model estimates <0.5 trajectories from LA1-LA13 contact Kivalina subsistence ERA 13 within 60 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 <0.5% trajectories contacting from LA1-LA13 within 60 and 360 days.

In winter, contact percentages within 60 and 360 days are <0.5% for ERA 13 and LSs 58-62 from LA1-LA13.

Kotzebue and Vicinity. For a summer spill, the OSRA model estimates a <0.5% of trajectories from LA1-LA13 contact Kotzebue and vicinity subsistence ERAs 13 and 5 within 60 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% trajectories contacting from LA1-LA13 within 60 and 360 days.

In winter, contact percentages within 60 and 360 days are <0.5% for ERAs 13 and 5 and LSs 47-58 from LA1-.

Shishmaref. For a summer spill, the OSRA model estimates a <0.5% chance of trajectories from LA1-LA13 contacting Shishmaref subsistence ERA 5 within 60 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 <0.5% trajectories contacting from trajectories from LA1-LA13 within 60 days and 360 days.

In winter, contact percentages within 60 and 360 days are <0.5% for ERA 5 and LSs 40-48 from LA1-LA13.

Wales. For a summer spill, the OSRA model estimates <0.5% of trajectories from LA1-LA13 contact Wales subsistence ERA 5 within 60 and 360 days. Land Segments 40 (Ah-Gude-Le-Rock/Mint River), 41 (Ikpek/Yankee River), and 42 (Arctic Lagoon/Nuluk River) have <0.5% trajectories contacting from LA1-LA13 within 60 days and 360 days. There are 1% trajectories contacting Boundary Segment 2 (WesternEastern Bering Strait) from LA 9 within 60 and 360 days.

In winter, contact percentages within 60 and 360 days are <0.5% for ERA 5 and LSs 40-42 from LA1-LA13. During winter, there are 1% trajectories contacting Boundary Segment 2 (Western Bering Strait) from LA 9 within 60 and 360 days.

Russian Arctic Chukchi Sea Coastal Communities. For a summer spill, the OSRA model estimates <0.5-7% trajectories from LA4-LA10 within 60 and 360 days contact the Enermino/Neshkan/Alyatki marine mammal harvest ERA 3. The OSRA model estimates 1-3% of trajectories from LA9-LA10 within 60 and 360 days contact the Naukan/Uelen/Inchoun/Chegitun marine mammal harvest ERA 4. In winter, the OSRA model estimates <0.5-% of trajectories from LA1-LA11 contacting the Enermino/Neshkan/Alyatki marine mammal harvest ERA 3 within 60 and 360 days. The OSRA model estimates 5% of trajectories from LA9 contacting the Naukan/Uelen/Inchoun/Chegitun marine mammal harvest ERA 4 within 60 and 360 days.

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 <0.5% trajectories contacting during summer and winter from LA1-LA13 within 60 days. Land Segment 8 has 1% of trajectories contacting from LA8 and LA 13 within 360 days. During winter, LSs 7 and 8 have 1% of trajectories contacting within 360 days from LA1 and LA 2.

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). During summer and winter,trajectory percentages within the 60 and 360days are <0.5% from LA1-LA13.

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). During summer and winter, contact percentages within the 60 and 360 days are <0.5% from LA1-LA13.

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 within the 60 and 360days are <0.5% from LA1-LA13.

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). During summer and winter, contact percentages for LSs 26, 28, and 29 within the 60days are <0.5% for all LAs. Land Segment 27 has 1% of trajectories contacting within 60 days in summer from LA4 and LA9. Within 360 days, LSs 26-29 have 1% of trajectories contacting from LA4, LA8 and LA9. In winter, Land Segment 27 has 1% trajectories contacting from LA4 and LA9; within 360 days, LSs 26-29 have 1% of trajectories contacting from LA1, LA4 and LA9.

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, the percentage of trajectories contacting for LSs 29-31 within 60 days are <0.5% for all LAs. Within 360 days summer, LSs 29-31 have 1% of trajectories contacting LA9. In winter, contact percentages for LSs 29 and 30 within 60 days are <0.5% for all LAs and LS 32 has 1% trajectories contacting from LA9. Within 360 days, LSs 29-31 have 1-2% of trajectories contacting from LA4 and LA9.

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 LSs 30 and 31 within 60 days are <0.5%. LSs 32 and 33 for the 60-day period have a 1% trajectories contacting from LA9. Within 360 days, LSs 30-33 have 1-2% of trajectories contacting during summer from LA9 and LA10. In winter, contact percentages for LSs 31 and 33 within the 60-day period are <0.5%. LSs 30 and 32 have a 1% trajectories contacting for winter trajectories from LA9. Within 360 days, LSs 30-33 have a 1-3% trajectories contacting from LA 4 and LA10.

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, LSs 34-36 have 1-2% trajectories contacting from trajectories originating from LA9 within the 60-day period. Within 360 days, LSs 34-36 have a 1-3% trajectories contacting from trajectories originating from LA9 and LA10. In winter, contact percentages for LSs 34-36 range from 1-2% within 60 days from LA9. Within 360 days, LSs 34-36 have a 1-5% trajectories contacting for winter trajectories from LA4, LA 9, and LA10.

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 1–2 percent of trajectories contacting from LA9 within 60 and 360 days during summer. In winter 1 percent of trajectories contacting LSs 36 and 37 from LA9 within 60 days; contact percentages for LS 38 are<0.5%. Within 360 days, LSs 36-38 have 2–4 percent of trajectories contacting from LA 9.

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 1-2% of trajectories contacting from LA9 within 60 days during summer. Within 360 days, LSs 37-39 have 1-2% of trajectories contacting from LA9. In winter there is 1% trajectories contacting LS 37 from LA9 within 60 days; contact percentages for LSs 38 and 39 are <0.5% within 60 days during winter. Within 360 days, LSs 37-39 have 1–3 percent of trajectories contacting from LA9.

The potential for bowhead whales to be contacted directly from trajectories originating from a VLOS is relatively small except in areas off Point Lay and Wainwright, but the potential trajectories contacting to whale habitat, whale migration corridors, and subsistence-whaling areas in the Chukchi Sea (both Russian and American waters) is considerably greater. Bowheaad whales may or may not be perceived as being contaminated, and the desire for bowhead whales may outweigh the concerns about contamination. Onshore areas and terrestrial subsistence resources for Point Lay and Wainwright have a high potential for trajectory contact.

Conclusion

If a VLOS 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 impacts 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 Lay, and Point Hope, and the beluga whale hunt in Point Lay for at least 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, polar bears, fish, and birds.

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 Iñupiat 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. Major impacts are expected from a VLOS when contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together (USDOI, MMS, 2009).

In considering lease sale alternatives, it is noted that LAs 8–13 generally exhibit higher percentages of spill contacting important subsistence areas along the U.S. Chukchi Sea coast. Deferring portions of LAs 8–13 (as proposed under Alternative IV and, to a greater extent, Alternative III) could in a sense slightly reduce the potential for VLOS-related impacts to subsistence activities in this region by decreasing the percentage of trajectories that would contact many important subsistence areas.

IV.E.16. Sociocultural Systems

Impacts from a VLOS would be expected to adversely impact sociocultural systems to the extent they adversely impacted subsistence harvests and practices. Sociocultural impacts of oil spills are of at least two types. The first is the result of direct effects on resources that are used in some way by local residents (i.e., subsistence, tourism, recreation, and elements of quality of life). The second is the impact of spill-cleanup efforts, in terms of short-term increases in population and economic opportunities, as well as increased demand on community services and increased stress to local communities (USDOI, MMS, 2007a). Potential VLOS effects on subsistence resources and practices were discussed in Section IV.E.14.

Effects on the sociocultural systems of local communities could be caused by 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. If there are concerns over the tainting of bowhead whales and other marine mammals from an oil spill, traditional practices for harvesting, sharing, and processing subsistence resources could be seriously curtailed in the short term, and overall effects from these sources could be expected to displace ongoing sociocultural systems (USDOI, MMS, 2007a).

Phase 1 (Initial Event)

In this phase, pre-existing stress created by fears of a large spill would be triggered. Such fears are pervasive in community testimonies as the following quote illustrates:

> People talk about the ocean getting more polluted if there is an oil spill, all the animals and vegetation in the ocean and the ducks and birds that live in the waters surrounding the spill. We see it on T.V. Every time there is a spill, they are cleaning animals. I don't know how it would look if you see some people dressed up in Tyvek suits trying to scrub off a polar bear or a walrus, or even a caribou. (Mr. William Tracey, Jr., Point Lay, Alaska, June 28, 2011)

Stress from this general fear can be broken down into particular fears: (1) being inundated during cleanup with outsiders who will disrupt local cultural continuity; (2) the damage that spills will do to the present and future natural environment; (3) the drawn out nature of oil-spill litigation; (4) the contamination of subsistence foods; (5) the lack of local resources to mobilize for advocacy and activism with regional, state, and federal agencies; (6) the lack of personal and professional time (capacity) to interact with regional, state, and federal agencies; (7) retracing the steps and the extensive public effort (and the frustrations involved) taken to oppose offshore development; (8) responding repeatedly to questions and information requests posed by researchers and regional, state, and federal outreach staff; and (9) having to employ and work with lawyers to draft litigation in attempts to stop proposed development (USDOI, MMS, 2007a).

Phase 2 (Offshore Oil)

The sociocultural impacts for this phase would blend with and closely resemble those described in Phase 1. Additional stresses produced at this phase would include fears about cleanup response capabilities or their lack. An ADF&G social-effects survey administered by the Division of Subsistence Management in 1994 in Nuiqsut included questions on effects from OCS development. About 60% of the respondents did not believe a small oil spill could be contained or cleaned up, and 80% did not believe a large oil spill could be contained or cleaned up (Fall and Utermohle, 1995; Impact Assessment, Inc., 1998; Field et al., 1999; USDOI, MMS, 2003a; USDOI, BLM and MMS, 2003).

If offshore subsistence-harvest areas were impacted by the spill and federal and state response agencies imposed area closures, subsistence harvests could be curtailed or cease completely in these areas and consequent sociocultural system impacts would be expected. Stress and fear would persist long term and would be a factor over a much larger area than just the locally impacted area.

Phase 3 (Onshore Contact)

Disruption of subsistence harvest resources from a VLOS 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 of each Native family's stored foods and the spectre of harvesting less preferred resources. Concerns over tainting would create a reluctance to consume suspect resources. The harvest of less-preferred resources is more time, labor, and equipment intensive. See the discussion of subsistence resource tainting concerns discussed in Section IV.E.14.

A VLOS would result in the contamination of subsistence resources and would be a threat to the health and lifestyle of the affected communities. If a VLOS affected a traditional-use area, then subsistence users would have to travel farther to harvest uncontaminated resources, which would result in high effects on sociocultural patterns for a much longer time than the period that subsistence resources would be measurably contaminated (USDOI, BLM, 2005).

Phase 4 (Spill Response and Cleanup)

Oil-spill employment (response and cleanup) could disrupt subsistence-harvest activities for at least an entire harvest season (and likely longer) and disrupt some sociocultural systems, and could further displace these systems, although cleanup activities alone are generally not sufficient alone to cause displacement. Spill cleanup would generate thousands of jobs and the sudden employment increases offered by wage work as spill cleanup workers could have sudden and severe effects, including inflation and displacement of Native residents from their normal subsistence-harvest activities. Cleanup is unlikely to add population to the communities because administrators and workers would likely live in separate enclaves, but cleanup employment of local Iñupiat could alter normal subsistence practices and put stresses on local village infrastructures by drawing local workers away from village service jobs. Oil-spill-cleanup activities should be viewed as an additional impact, causing displacement of subsistence resources and subsistence hunters and employment disruptions (see Impact Assessment, Inc., 1998; USDOI, BLM, 2005).

Phase 5 (Long-term Recovery)

A VLOS can lead to a disruption of the kinship networks (i.e., social organization), which in turn could lead to a decreased emphasis on the importance of the family, cooperation, and sharing. Multiyear disruptions of subsistence-harvest patterns, especially to the bowhead whale (an important species to the Iñupiat culture), could disrupt sharing networks, subsistence-task groups, and crew structures and could cause disruptions of the central Iñupiat cultural value: subsistence as a way of life. These disruptions also could cause a breakdown in sharing patterns, family ties, and the community's sense of well-being and could damage sharing linkages with other communities. Other effects might be a decreasing emphasis on subsistence as a livelihood, with an increased emphasis on wage employment, individualism, and entrepreneurism. Effects on the sociocultural system, such as increased drug and alcohol abuse, breakdown in family ties, and a weakening of social well-being, could lead to additional stresses on the health and social services available. Effects on the sociocultural systems described above would be expected to persist for many years and likely much longer, placing additional stress on the sociocultural systems with trends toward displacement of existing institutions (USDOI, MMS, 2007a, 2008a).

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 harvesting 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 continued, 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 through consolidation of households to save money, placement of dependents with relatives beyond the village, and outmigration of wage earners in search of employment. These could further deplete the pool of available subsistence producers and would affect the structure of households and reduce the stability of families and communities (USDOI, BLM, 2008a).

Stress to subsistence and sharing could affect the very central core values of the Iñupiat culture. The inability of the community's leaders—the subsistence providers—to fulfill their roles 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 harvests and the 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. Individuals and communities would be increasingly stressed during the time it would take to modify subsistence-harvest patterns by selectively changing harvest areas (if such areas were even available) and there would be increased costs and risks associated with travel and hunting in unfamiliar areas. Associated cultural activities, such as the organization of subsistence activities among kinship groups and the relationships among those who customarily process and share subsistence harvests, would also be modified or would decline (USDOI, BLM, 2008).

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 (USDOI, BLM, 2008).

Research of the long-term effects of Exxon Valdez oil spill by Fall et al. (2001) and Impact Assessment, Inc. (2001) indicated the following effects likely to be realized from a VLOS: (1) communities highly dependent on subsistence (“wild”) foods would be most vulnerable to the effects from an oil spill (in these communities, self-identities and family life are organized to a larger extent around seasonal harvest distribution and use of foods, and cultural survival is tied to the traditional use of food); (2) both the level of distress and sense of loss would increase with proximity to the spill and the degree of oiling; (3) the lingering presence of oil in the environment would lead to continuing avoidance of subsistence-harvest resources; (4) the short-term depression of the subsistence-food harvest and food use would not necessarily lead to long-term sociocultural losses, such as loss of cultural knowledge, skills, or values within families. In fact, concerns about potential sociocultural effects led in many instances to intensification of economic and cultural revitalization as a social movement in communities; (5) during cleanup, the effort of village residents would be redirected from subsistence activities to wage-sector employment and redirected between cash/and noncash activities; (6) the traditional organization of the subsistence sector would not necessarily be eroded by the spill; (7) concern over contamination of subsistence resources would persist, and confidence in the benefits of eating natural foods would erode: (8) no major demographic changes would necessarily occur (apparent outmigration of residents did not take place in the case of the Exxon Valdez oil spill—there also was not a permanent immigration—and the surge of population with initiation of cleanup activities subsided with curtailment of those activities); and (9) the purchase of lands for conservation areas would cause losses to the Native Alaskans land base, while creating new opportunities for income and investment. These conditions indicate that a very large oil spill did cause chronic disruption for a period of time after the spill but that existing social patterns, although affected, were not displaced. That is, the social structure of villages, towns, and cities, while affected by a very large oil spill, continued and persisted in the aftermath of the spill (Picou et al., 1992; Cohen, 1993; Picou and Gill, 1993; Fall, 1992; Impact Assessment, Inc., 1990c; Fall and Utermohle, 1995; Human Relations Area Files, Inc., 1994).

The Impact Assessment, Inc. (2001) study added additional consideration of psychological and identity impacts from the spill. These authors emphasized that for Alaskan Natives, the early impacts of the spill were compounded by the sense of “fear” about resource safety and the “alienation” from culturally valued activities this caused. These authors also noted that continuing litigation contributes to continuing psychological impacts of the spill. While this report did not include new data from the 10-year, postspill time period, some of the reported impacts would have been mitigated by the general recovery in subsistence harvest practices (USDOI, MMS, 2003a; USDOI, BLM and MMS, 2003). A study by Picou et al. (1992) showed that 18 months following the EVOS, residents of Cordova had experienced long-term negative social effects—disruption to work roles and increased personal stress. Additionally, they observed that work disruption was correlated with intrusive stress and fishermen experienced more work disruption than other occupations. It may be possible that other natural resource community activities such as participation in subsistence harvests may identify subpopulations more vulnerable to long-term negative social impacts (Picou et al., 1992).

Another good source of information on spill effects is the *Social Indicators Study of Alaskan Coastal Villages, Volume VI: Analysis of the Exxon Valdez Spill Area, 1988-1992* (Human Relations Area Files, Inc., 1994). The summary of findings section affirmed that immediately after the spill and continuing into early 1990, Native people decreased their harvests of wild resources and relied on preserved foods harvested before the spill. By winter 1991, the Natives' normal harvesting activities had begun to resume, but the proportions of wild foods in their diets remained below those of 1989. The study also demonstrated in its analysis that non-Natives and Natives "define the environment and resources within the environment very differently. Commodity valuation takes precedence" for non-Natives and "instrumental use and cultural and spiritual valuation take precedence" for Native people (Human Relations Area Files, Inc., 1994). An overall study on 21 Alaskan communities concluded that impacts from the EVOS on subsistence use and the social and cultural system that subsistence activities support persisted (Fall and Utermohle, 1995; Impact Assessment, Inc., 1998; Field et al., 1999; USDOI, MMS, 2003a, 2007a; USDOI, BLM and MMS, 2003).

A VLOS in the Chukchi Sea would be expected to affect individuals and social systems in ways similar to the effects of the Exxon Valdez oil spill. As shown by that spill, some individuals found a new arena for pre-existing personal and political conflict, especially over the dispensation of money and contracts. In the smaller communities, clean-up work produced a redistribution of resources, creating new schisms in the community and increasing social stresses. Many members of small communities were on the road to sobriety before the spill; after the spill, many people were drinking again, leading to the re-emergence of numerous alcohol-related problems (such as child abuse, domestic violence, and accidents). Institutional effects included additional burdens on local governments, the disruption of existing community plans and programs, strain on local officials, difficulty dealing with Exxon, community conflicts, disruptions of customary habits and patterns of behavior, emotional effects and stress-related disorders from confronting environmental degradation and death, and violation of community values (Endter-Wada, 1992). Post-spill stress resulted from the seeming loss of control over individual and institutional environments, as well as from secondary episodes such as litigation, which produced secrecy over information, uncertainty over outcomes, and community segmentation (Smythe, 1990). Attempts to mitigate social effects were often ineffective because of concerns over litigation, causing a reluctance to intervene out of fear that these actions might benefit adversaries in legal battles (Impact Assessment, Inc., 1990b, 1998; Human Relations Area Files, Inc. 1994; ADF&G 1995). In response to spill hazards, there was a resurgence in traditional strategies for responding to resource shortages, which in traditional times, and following the spill, resulted in an increase in sharing, a renewal and strengthening of social connections with extended family members and friends, and a cooperative approach to subsistence activities within and between the most affected communities (USDOI, BLM, 2008).

In general, "perceptions of risk" exist among local residents concerned about oil spills and manifest in fears and concerns for stakeholder cultural rights and resources. Considering the importance of social networks that are maintained through subsistence-harvest patterns and sociocultural systems, 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.

Oil Spill Trajectory Analysis

Above we have addressed the potential impacts to sociocultural systems during each phase of the hypothetical scenario. Impacts on sociocultural systems are directly related to impacts on subsistence-harvest patterns (see Section IV.E.14, subsistence-harvest patterns). The oil spill trajectory analysis for subsistence resources and practices would therefore also apply here for sociocultural systems.

Conclusion

The effects of a VLOS on sociocultural systems could cause significant adverse effects via chronic disruption to sociocultural systems for several years with a tendency for additional stress on the sociocultural systems. Longer term disruptions to subsistence resources and practices would 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 (USDOI, MMS, 2007a).

These disruptions could cause breakdowns in family ties, a community’s sense of well-being, and damage sharing linkages with other communities and could seriously curtail community activities and traditional practices for harvesting, sharing, and processing subsistence resources—a major impact on sociocultural systems. The effects of disruption to sociocultural systems would last beyond the period of oil-spill cleanup and could lapse into a chronic disruption of social organization, cultural values, and institutional organization with a tendency to displace existing social patterns. The accommodation response of Iñupiat culture in itself to the impacts of a VLOS could represent major impacts to social systems (USDOI, MMS, 2003a, 2006a, 2007a; USDOI, BLM and MMS, 2003). Similar to Subsistence Harvest-Patterns, the potential for significant impacts could be reduced by implementing larger a larger deferral area under Alternative IV or, to a greater extent, Alternative III.

IV.E.17. Archaeological Resources

A VLOS and subsequent cleanup could impact the archaeological resources of the Chukchi Sea and coastline directly, indirectly, or both. Beached shipwrecks, shipwrecks in shallow waters, and coastal historic and prehistoric archeological sites could all be adversely affected. Protection of archaeological resources during an oil spill requires specific knowledge of the resource's location, condition, nature, and extent prior to impact. However, large portions of the coastline have not been systematically surveyed for archaeological sites. The sites that are known include those on or eligible for the National Register of Historic Places under the NHPA, sites also referred to as historic properties.

Archaeological surveys and analyses are required in areas where potential archaeological resources are at risk from offshore operations. These efforts would be required prior to any exploration activities and, by extension, the events that constitute the VLOS scenario. Applicable requirements are specified by:

- BOEMRE Handbook 620.1H, Archaeological Resource Protection.
- BOEMRE 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)).
- BOEMRE Alaska Region NTL No. 05-A03, Archaeological Survey and Evaluation for Exploration and Development Activities.
- The National Historic Preservation Act of 1966 (NHPA), as amended.
- Regulations implementing the NHPA at 36 CFR 800, Protection of Historic Properties.

Historic properties, including onshore and offshore archaeological resources, will be identified before any proposed activities are permitted, and they will be avoided or potential effects will be mitigated.

After the Exxon Valdez spill, the Advisory Council on Historic Preservation declared that all archaeological sites were to be treated as if they were significant and eligible for the National Register of Historic Places (USDOI, MMS 2007a, 2009; USDOI BLM, 2008). This analysis assumes that significant effects occur whenever unique archaeological information is lost.

Phase 1 (Initial Event)

Onshore archaeological resources (prehistoric and historic sites) would not be immediately impacted during the initial phase of a very large oil spill because the distance of a blowout site from shore is at least 25 miles. However, a large blowout could impact submerged offshore archaeological resources within close vicinity. Such resources could be damaged by the high volume of escaping gas, buried by large amounts of dispersed sediments, crushed by the sinking of the rig or platform, destroyed during relief well drilling, or contaminated by hydrocarbons (USDOI, BOEMRE, 2011). The potential for impacts to any adjacent shipwrecks is high.

Given the limited data related to historic ship losses and prehistoric paleo-landforms in the Chukchi Sea area, it is difficult to determine how many historic properties might be located in areas affected by the hypothetical VLOS scenario. However, the potential of a well being drilled close enough to damage or bury a known prehistoric or historic resource, such as a shipwreck, is low given measures required during planning for exploration. Archaeological surveys are required prior to any exploration (and for that matter, development and production) activities to identify anomolies such as shipwrecks and other geomorphical features. In the past, BOEMRE has required surveys only on leases within blocks deemed to have a high potential for containing historic and/or prehistoric resources. Because all of the submerged lands in the Chukchi Sea had been part of the Bering Land Bridge at the end of the Pleistocene, they have the potential to contain historic properties. Avoidance mitigation resulting from these surveys would further protect historic and prehistoric archaeological resources from the potential impacts of a catastrophic blowout (USDOI, BOEMRE, 2011). Additional surveys to identify the locations of archaeological resources in the Chukchi Sea region would prove valuable in assessing and protecting historic properties in the region. However, this information is not considered essential for a reasoned choice among lease sale alternatives for reasons explained in Section IV.C.16. Further, it would be infeasible at this time to collect detailed information for all of the locations that could potentially be affected in the event of a VLOS.

Phase 2 (Offshore Oil)

There is a possibility that oil from a catastrophic blowout could come in contact with wooden shipwrecks and artifacts on the seafloor and accelerate their deterioration (USDOI, BOEMRE, 2011). A recent experimental study has suggested that, while the degradation of wood in terrestrial environments is initially retarded by contamination with crude oil, at later stages, the biodeterioration of wood was accelerated (Ejechi, 2003). Regardless of water depth, because oil is a hydrocarbon, heavy oiling could contaminate organic materials associated with archaeological sites, resulting in erroneous dates from standard radiometric dating techniques (e.g., 14C-dating). Interference with the accuracy of 14C-dating would result in the loss of valuable data necessary to understand and interpret the sites (USDOI, BOEMRE, 2011).

Phase 3 (Onshore Contact)

A very large oil spill would affect onshore archaeological sites the most. In the event of a VLOS scenario, it is estimated that 150 to 850 miles of discontinuous shoreline could be oiled to some degree. Onshore prehistoric and historic sites would be impacted to some extent if a high-volume spill reaches shore. Sites on barrier islands could suffer the heaviest impact. Oil contamination of shorelines from a very large oil spill is a potential direct impact that would affect archaeological site recognition. Crude oil also may contaminate organic material used in C14 dating and, although there are methods for cleaning contaminated C14 samples, greater expense is incurred (Dekin et al., 1993).

It should be noted that other anthropogenic sources of hydrocarbons and other possible contaminants also exist, so caution should always be taken when analyzing radiocarbon samples from coastal Alaska (see Reger, McMahan, and Holmes, 1992; USDOI, MMS 2007a, 2009). Despite these risks, past events have shown that spilled oil itself has little direct effect on archaeological resources (Bittner, 1993). The most significant damage to archaeological sites could be related to cleanup and response efforts (USDOI, BOEMRE, 2011).

Phase 4 (Spill Response and Cleanup)

Various aspects of a VLOS response and cleanup have some potential to adversely affect archaeological resources.

Offshore archaeological resources could be disturbed by vessel anchoring. However, ancillary damages from vessels associated with oil-spill response activities (e.g., anchoring) are unlikely due to the use of dynamically positioned vessels responding to a VLOS. If response and support vessels were to anchor near a deepwater blowout site, the potential to damage undiscovered vessels in the area would be high due to the required number and the size of anchors and the length of mooring chains needed to safely secure vessels. Additionally, multiple offshore vessel decontamination stations would likely be established in shallow water outside of ports or entrances to inland waterways, as seen for the DWH event. The anchoring of vessels could result in damage to both known and undiscovered archaeological sites; the potential to impact archaeological resources increases as the density of anchoring activities in these areas increases (USDOI, BOEMRE, 2011).

It is possible that large quantities of subsea dispersants could be used during spill response. This could result in unintended effects from dispersed oil droplets settling to the seafloor. Though information on the actual impacts to submerged cultural resources is inconclusive at this time, oil settling to the seafloor could come in contact with archaeological resources. At present, there is no evidence of this having occurred at sites in the Gulf of Mexico potentially affected by the DWH event (USDOI, BOEMRE, 2011).

The potential for damaging archaeological resources increases as the oil spill and related response activities progress landward. In shallower waters, most of the damage would be associated with oil cleanup and response activities. Hundreds of vessels would respond to a shallow-water blowout and would likely anchor, potentially damaging both known and undiscovered archaeological sites. Additional anchoring would be associated with offshore vessel decontamination stations, as described above. As the spill moves into the intertidal zone, the chance of direct contact between the oil and archaeological resources increases. As discussed above, this could result in increased degradation of wooden shipwrecks and artifacts (USDOI, BOEMRE, 2011).

Onshore, oil-spill-cleanup activities in the event of a VLOS and any other activity that removes or disturbs soil and/or causes shallow permafrost to thaw have the potential to disturb archaeological resources. Because cultural resources are located at or near the ground surface, a spill that occurred during the summer would have a greater effect on these resources than a spill that occurred during the winter. Oil spilled during winter, however, could impact cultural resources if the warm oil melted the snow and permafrost and impacted the underlying cultural resources. While the contamination of the cultural resources would render some of the data recovery valueless, the clean-up procedures would create even greater impacts. Since cultural resources are nonrenewable, the effects could result in loss of site integrity (USDOI, MMS 2007a, 2009; USDOI, BLM, 2008).

Any onshore activity (cleanup or otherwise) that brings development in contact with remote areas has the potential to expose archaeological resources to disturbance from construction or from vandalism. Historic sites, such as hunting, fishing, and whaling camps, or structures associated with settlements or the Distant Early Warning (DEW) Line (a system of radar stations) could be affected by increased cleanup activity in remote areas and increased vandalism. Prehistoric sites, though often not as visible as historic sites, also might be subjected to increased vandalism, as well (USDOI, MMS 2007a, 2009; USDOI BLM, 2008).

Protection of an archaeological resource during an oil spill requires specific knowledge of the resource’s location, condition, nature, and extent prior to impact. 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 (USDOI, MMS, 2007a, 2009).

However, large portions of the Alaska Region coastline have not been systematically surveyed for archaeological sites. While some response groups have compiled known archaeological site data in a form useful for mitigation during an emergency response (Wooley, Hillman, and O’Brien, 1997), these data have not been compiled for all areas of the Alaska Region. Subarea plans for the North Slope, Cook Inlet, and Prince William Sound reference procedures for addressing and mitigating potential impacts to archaeological resources should an oil spill occur. Interagency and regulatory aspects of oil spill archaeological site protection recently have been clarified. A programmatic agreement specifies the Federal On-Scene Coordinator’s role in protecting archaeological resources, the type of expertise needed for site protection, and the appropriate process for identifying and protecting archaeological sites during an emergency response. Under the agreement, the Federal On-Scene Coordinator’s Historic Properties Specialist coordinates and directs the site identification and protection program, with consultation and cooperation of the Unified Command and other affected and interested parties (Alaska Regional Response Team, 1997, 2000; USDOI, MMS 2007a, 2009).

Indeed the major source of potential impact from oil spills is the harm that could result from unmonitored shoreline cleanup activities. Cleanup activities could impact beached shipwrecks, or shipwrecks in shallow waters, and coastal historic and prehistoric archaeological sites. Unmonitored booming, cleanup activities involving vehicle and foot traffic, mechanized cleanup involving heavy equipment, and high pressure washing on or near archaeological sites pose risks to archaeological resources. Exposure of undocumented sites increases the possibility of vandalism. Increased human presence and activity increases the potential for archaeological sites to be recognized, resulting in the site having a higher chance of being vandalized. The discovery and reporting of archaeological sites during cleanup activities also would result in their being documented and protected. Unauthorized collecting of artifacts by cleanup crew members also is a concern, albeit one that can be mitigated with effective training and supervision. As Bittner (1993) described in her summary of the 1989 Exxon Valdez oil spill: “Damage assessment revealed no contamination of the sites by oil, but considerable damage resulted from vandalism associated with cleanup activities, and lesser amounts were caused by the cleanup process itself” (USDOI, MMS 2007a, 2009).

A State University of New York at Binghamton study evaluated the extent of petrochemical contamination of archaeological sites as a result of the Exxon Valdez oil spill; it examined the effects of the spill on archaeological deposits and found that oil in the intertidal zone had not penetrated the subsoil, apparently due to hydrostatic pressure. Researchers concluded that the three main types of damage to archaeological deposits were oiling, vandalism, and erosion, but that fewer than 3% of the resources would suffer significant effects (Dekin et al., 1993; USDOI, MMS 2007a, 2009). Two studies of intertidal disturbance, the Exxon Valdez oil spill Cultural Resource Program and a paper on archaeological protection presented at the Atlanta meeting of the American Society for Testing and Materials, are in close agreement as to the effects of the spill on shoreline and intertidal resources. In the first study by Mobley et al. (1990), there were 1,000 archaeological sites in the area affected by the Exxon Valdez oil spill and about 24 of these, or 2.4%, were damaged (Mobley et al., 1990). In the second study (Wooley and Haggarty, 1993), a total of 609 sites were identified and of these, 14, or 2.3%, were damaged. The findings of these two studies agree that less than 2.3%-2.4% of the sites in the area affected by the Exxon Valdez oil spill suffered damage. 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 occurred (Mobley et al., 1990; USDOI, MMS 2007a, 2009).

As a result of lessons learned from the EVOS, cultural resources were recognized as significant early on in the response to the DWH event, and archaeologists were embedded in Shoreline Cleanup Assessment Teams (SCAT) and consulted with cleanup crews. Historic preservation representatives were present at both the Joint Incident Command as well as each Area Command under the general oversight of the National Park Service to coordinate response efforts. Despite these efforts, some archaeological sites suffered damage from looting or from spill clean-up activities (USDOI, BOEMRE, 2011). Increased knowledge of archeological resource locations, coupled with increased levels of human activity in these areas, can lead to increased vandalism of sites. Various mitigation 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; Wooley and Haggarty, 1993; USDOI, MMS 2007a, 2009).

Phase 5 (Long-term Recovery)

Unlike biological resources that have the potential to recover, damage to archaeological resources from a very large oil spill and its cleanup activities would be irreversible, leading to the loss of important archaeological data needed for proper study and interpretation (USDOI, BOEMRE, 2011). Long-term effects of oiling on prehistoric and historic archaeological resources are poorly understood; however, oiling could alter the surrounding site dynamics and increase their degradation. In addition, onshore habitat degradation could lead to erosion, which would increase exposure to and subsidence of prehistoric and historic sites.

Oil Spill Trajectory Analysis

It is difficult to prioritize any areas of the Chukchi Sea and coastline as more important for archaeological resources, because the locations of archaeological resources are largely unknown. However, the EVOS event demonstrated that potential impacts increase as coastal spill response and cleanup activities increase. A hypothetical spill which affects larger areas of the coastline may in this sense pose more potential for significant impacts to archaeological resources. In terms of oil spill impacts, the oil spill trajectory Land Segment analysis for subsistence-harvest patterns would apply here for archaeological resources (See Section IV.C.14, Subsistence-Harvest Patterns).

Conclusion

The greatest impacts on archaeological resources from a very large oil spill would be to onshore archaeological sites from oil-spill-cleanup activities. The potential for effects increases with oil-spill size and associated cleanup operations. Primary oil-spill impacts from cleanup activities would be expected on both prehistoric and historic archaeological sites. Following the Exxon Valdez oil spill, the greatest effects came from vandalism, because more people knew about the locations of the resources and were present at the sites. Offshore resources are at greatest risk from bottom-disturbing activities, notably anchoring and anchor dragging.

Although it is not possible to predict the precise numbers or types of sites that would be affected, contact with archaeological sites would probably be unavoidable and the resulting loss of information would be irretrievable. The magnitude of the impact would depend on the significance and uniqueness of the information lost. It is difficult to draw a distinct correlation between the potential for archaeological impacts from a VLOS and the implementation of deferral corridors under various lease sale alternatives. Because impacts to archaeological resources would not vary under the different action alternatives, additional information about the location of currently unknown resources is not essential to a reasoned choice among lease sale alternatives.

The most effective way to avoid adverse impacts from a VLOS would be to focus on effective surveying of potential exploration sites and the various mitigating measures used to protect archaeological sites while cleaning up oil spills. The latter category should include 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; USDOI, MMS 2007a, 2009).

IV.E.18. Environmental Justice

Any significant adverse impacts to subsistence resources and harvests or sociocultural systems from a VLOS would represent significant environmental justice impacts, i.e. disproportionate, high, adverse environmental and health effects on low-income, minority populations in the region. Alaskan Iñupiat Natives, a recognized minority, are the predominant residents of Chukchi Sea coastal communities in the NSB and NWAB, the region potentially most affected by a VLOS. Eighty-three percent of the population of the NSB, and 87% of the NWAB are defined minority populations.

Environmental Justice (EJ) is an initiative promoted by 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 on Native subsistence activities.

A pivotal part of any EJ analysis—as it directly relates to the EO's charge to examine "human health and environmental effects…on minority populations and low income populations"—is a discussion of all human health factors that figure into the overall health and well being of indigenous populations on the North Slope and in the Northwest Arctic. A very large oil spill would exacerbate and magnify these factors that include: (1) existing regional health pathologies (increased diabetes, etc.); (2) social pathology (assault, alcohol and drug abuse, domestic violence, suicide, and homicide); (3) major employment fluctuations; (4) major changes in economic development; (5) stresses associated with sociocultural change (acculturation, an influx of oil-spill workers, increases in the economic standard of living, changes in education, etc.); and, (6) changes in environmental quality. Collectively these are described as the social determinants of health that encompass the 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. For a more in-depth treatment of these factors, see Section III.C.1.p in the Sale 193 FEIS.

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 Iñupiat villages (e.g., teachers, CIP employees, oil workers); stress over perceived and actual threats to culture and subsistence; direct and indirect employment opportunities; and broad economic and infrastructure improvements. It is important to recognize that the potential from changes brought by the oil and gas development that this VLOS scenario assumes may create statewide, regional, and local (village-level) effects, as described above. Furthermore, it must be understood that effects on social determinants of health (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. A very large oil spill event would impinge on and influence all the factors mentioned above.

In the event of a VLOS, many of the aforementioned EJ impacts associated with routine oil and gas activities could intensify. Iñupiat Natives are especially susceptible to negative impacts due to their reliance on subsistence foods. Subsistence resources and harvest practices, sociocultural systems, and human health could all be significantly affected. Potential effects would focus on the Iñupiat communities of Barrow, Wainwright, Point Lay, Point Hope, and other subsistence communities, including those along the Russian Arctic Chukchi Sea coast. If a very 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. In general, the central issue of effects on subsistence will be used as a proxy or construct for potential EJ impacts.

The sociocultural impacts of a very large oil spill on Alaskan Native communities are interconnected with the subsistence lifestyle of these communities and would have consequent environmental justice impacts. Subsistence embodies the traditions of Alaskan Native culture with overlapping connections to other cultural, social, and economic institutions. In addition, some effects may be felt well beyond the villages, given the extensive subsistence-food-distribution networks that extend to members in other places. The damage to natural resources used for subsistence may result in a disruption of harvesting, processing, and sharing. Such damage can affect the essential connections between sociocultural factors of individual identity, social group, culture, and nature. Given the overarching importance of subsistence resources to the indigenous populations—all defined minority populations—any major impacts to subsistence resources that create attendant major impacts on Alaskan Native sociocultural systems would be expected to have consequent disproportionate, high adverse impacts on environmental justice. A community member from Point Lay puts these concepts into more personal terms:

> So we come back from a four-hour hunt, my nephew and his girlfriend. We just got back. And to us, it is Eskimo heaven. It's where our spirituality is – is completed. What we can't get from the land, we can get from the sea, the marine mammals that we are concerned about, about being devastated in the event. And this is what bothers our people. In the unlikely event of an oil spill…what technology do you have to clean it up? (Mr. Delbert Rexford, Pt. Lay, Alaska, June 28, 2011)

Possible oil-spill contamination of subsistence foods is a serious concern to Native health. Subsistence is the cornerstone of nutrition, culture, and social systems in NSB communities. A vital, productive subsistence way of life is strongly correlated with measures of overall well-being and psychosocial health in Arctic communities (Poppel et al., 2007; Hicks and Bjerregaard, 2006; Shepard and Rode, 1996). Impacts to the subsistence harvest, if severe enough, would also impact food security, nutritional status, and the risk of nutritionally based chronic medical problems such as high blood pressure, obesity, diabetes, and cardiovascular disease. The effects of contaminant-related health effects related to an oil spill are difficult to study. For example, exposure to benzene and other hazardous air pollutants (HAPs) near a spill could be high enough to increase the risk of rare cancers such as leukemia. However, because of the small population size in Chukchi Sea coastal villages, linking a change in incidence of such a cancer to an environmental exposure is statistically difficult. Nevertheless, for contaminants with well-characterized toxicological profiles such as benzene and specific PAHs, exposure is known to produce adverse health effects, and should be considered a major adverse health effect of a VLOS if individuals or communities are exposed (USDOI, MMS, 2008a).

Anyone dependent on subsistence resources could experience these effects to some degree, but they would be most prominent in Iñupiat residents of the region where current data suggest that subsistence is a cornerstone of general wellbeing as well as physical health.

Human health could be threatened because of the risk of consumption of contaminants in areas affected by oil spills. Risks can be reduced 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. 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. Based on these findings, 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). However, they recommended avoiding shellfish, which accumulates hydrocarbons.

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 of these foods remained (and remain today) in Native communities in Prince William Sound and the region 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). Given the prominent and irreplaceable role of subsistence foods in local diets, it is apparent that both actual and perceived contamination can cause adverse impacts to EJ.

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. 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; USDOI, MMS, 2007a).

Phase 1 (Initial Event)

Given the location of a hypothetical blowout more than 25 miles or more from the shore, as well as the short duration of an ensuing fire, the initial event is not expected to impact land resources. No environmental justice impacts would directly result from these components of the scenario. On the other hand, pre-existing stress created by fears of a very large oil spill—now realized, in fact—would be triggered. Such stress could be interpreted to be a disproportionate impact on the local Iñupiat population (see discussion on this point within Section IV.C.15, Sociocultural Systems).

Indirect impacts from a spill originating within the Chukchi Sea region could 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 Iñupiat and Yup'ik Eskimo communities in the Chukchi (including indigenous people on the Russian Chukchi Sea coast) and those portions of the Bering Sea adjacent to the migratory corridor used by whales and other migrating species.

Phase 2 (Offshore Oil)

Environmental justice impacts during this phase would blend with and closely resemble those described in Phase 1. Again, impacts described in the sociocultural systems discussion (see Section IV.C.15) are relevant here. If offshore subsistence-harvest areas were impacted by the spill, subsistence harvests could be curtailed or cease completely in these areas and consequent sociocultural and environmental justice impacts would be expected. A VLOS preventing traditional subsistence activities in the offshore waters of the Chukchi Sea would disproportionately impact the Alaskan Iñupiat Natives, a defined minority population.

Phase 3 (Onshore Contact)

To the extent that a VLOS affected local subsistence resources and practices and sociocultural resources—social organization, cultural values, and institutional organization—consequent impacts on environmental justice would be expected. Further discussion of subsistence resource tainting concerns and potential impacts to sociocultural systems are discussed in sections IV.C.14 and IV.C.15, respectively. Contamination of subsistence resources poses a threat to the health and lifestyle of the affected communities. Consumption of contaminated resources would likely lead to increases in contaminant-related health problems such as cancer and neurodevelopmental delays. In the short term, these problems might be lessened by avoidance of contaminated resources, but chronic persistent low-level contamination many years after the spill could cause incremental increases in these problems (USDOI, BLM, 2008; USDOI, MMS, 2008a). If a VLOS occurred in or reached a traditional-use area, subsistence users would also have to travel farther to harvest uncontaminated resources. Alterations in harvest patterns could result in major effects on sociocultural patterns as well as increased safety risks during harvesting. The onshore contact phase thus poses the greatest potential for disproportionate, high adverse impacts on environmental justice.

Phase 4 (Spill Response and Cleanup)

A VLOS in the Chukchi Sea would trigger a wide-scale and protected spill response and cleanup effort. As illustrated by the EVOS, this Phase could implicate environmental justice considerations in several ways. Paid employment of local residents in cleanup efforts could curb participation in subsistence activities and alter normal subsistence practices. Given the urgency of cleanup efforts activities could also draw local workers away from village service jobs, which also tend to be lower paying. On the other hand, increased employment and income are generally associated with positive health outcomes.

A rapid influx of nonresident personnel to or through a community is likely, and could lead to increased social and psychological problems. Adverse impacts could occur via social interactions and commerce-related factors such as the local economy and inflation. In general, the larger the spill, the more dramatic the expected changes as they related to social upheaval and implications for health (Human Relations Area Files, Inc., 1995; ADFG, 1995b; Impact Assessment, Inc., 1990c, 1998). The rapid influx of cash, the influx of nonresident workers to and through coastal communities, and short-term and unstable employment increase the risk of infectious disease transmission, potentially compromising the efficacy of local prohibition laws in preventing adverse health effects from alcohol consumption, and could exacerbate social and psychological strain leading to maladaptive behavior, including violence and alcohol and drug abuse. The adverse health effects of insecure or unstable employment are similar to unemployment in many studies (Marmot and Wilkinson, 2004). Interference with subsistence seasonal activities would have implications for nutritional health and chronic diseases, such as diabetes. Such impacts could be in play as long as oil-spill response occurred and likely thereafter, and have lingering environmental justice impacts.

The lack of any well established and extensive onshore infrastructure within the Chukchi Sea region could compromise the efficacy of response efforts, heightening and prolonging the impacts described above. Harsh weather conditions and movement of pack ice in the Chukchi Sea would present novel challenges for oil-spill cleanup which could increase the risk of public health problems resulting from exposure to contaminants and the perceived risks of subsistence resource contamination. Should Federal and State response agencies close affected areas to harvest, additional impacts to subsistence could occur.

Phase 5 (Long-term Recovery)

In the event of a very large oil spill, considerable stress and anxiety would occur over the loss of subsistence resources, contamination of habitat and subsistence resources, fear of the health effects of eating contaminated wild foods, fear of changes to harvest regulations (e.g., quotas), and the need to depend on the knowledge of others about environmental contamination (Fall 1992, McMullen 1993). Reductions in subsistence game populations, displacement of game, and fears of contamination could combine to substantially reduce subsistence game intake. If this occurred, the prevalence of diabetes and related metabolic disorders would be expected to increase substantially; increases in contaminant-related health problems such as cancer and neurodevelopmental delays could also be expected. Food insecurity would increase markedly, and unless sharing networks and government programs were able to respond rapidly, hunger and potentially (though less likely) malnutrition could result (USDOI, BLM, 2008; USDOI, MMS, 2008a)

Social pathology would likely increase, and, in parallel with increased social pathology and more difficult hunting conditions, injury rates and mortality could also increase. In the case of the Exxon Valdez oil spill, many members of small communities were on the road to sobriety before the spill; after the spill, some people began drinking again, leading to the re-emergence of numerous alcohol-related problems (such as child abuse, domestic violence, and accidents). Institutional effects included additional burdens on local governments, disruption of existing community plans and programs, strain on local officials, difficulty dealing with Exxon, community conflict, disruptions of customary habits and patterns of behavior, emotional effects and stress-related disorders from confronting environmental degradation and death, and violation of community values (Endter-Wada, 1992). Post-spill stress resulted from the seeming loss of control over individual and institutional environments, as well as from secondary episodes such as litigation, which produced secrecy over information, uncertainty over outcomes, and community segmentation (Smythe, 1990). Attempts to mitigate social effects were often ineffective because of concerns over litigation, causing a reluctance to intervene out of fear that these actions might benefit adversaries in legal battles (Imapct Assessment, Inc., 1990a, 1998; Human Relations Area Files, Inc. 1994; ADFG 1995; USDOI, BLM, 2008; USDOI, MMS, 2008a).

Impacts to the social determinants of health, possible after a very large oil spill, are some of the most serious adverse social products of such a catastrophic event. If, as in the Exxon Valdez oil spill, the disruption of sharing networks and increases in social pathology were extensive and persistent, substantial decreases in social capital could occur, with ramifications for not only psychosocial health but physical health as well (Ritchie and Gill, 2004; Marmot and Wilkinson 2004; USDOI, BLM, 2008).

Another primary environmental justice concern would relate to possible long-term health impacts to cleanup workers, a predominately minority population if local communities supplied cleanup personnel, and to possible disposal of oil-impacted solid waste in the region—a predominantly minority area. A very large oil spill in the region could also bring in large numbers of non-local minority workers for response and cleanup, adding an entirely new layer to environmental justice concerns in the region. With the DWH event, the racial composition of cleanup crews was so conspicuous that Ben Jealous, the president of the National Association for the Advancement of Colored People (NAACP), sent a public letter to BP Chief Operations Officer Tony Hayward on July 9, 2010, demanding to know why African Americans were over-represented in “the most physically difficult, lowest paying jobs, with the most significant exposure to toxins” (NAACP, 2010). While regulations require the wearing of protective gear and only a small percentage of cleanup workers suffer immediate illness and injuries (CDC, 2010), exposure could have long-term health impacts such as increased rates of some types of cancer (Savitz and Engel, 2010; Kirkeleit et al., 2008). Therefore, a catastrophic spill could disproportionately affect onshore low income and minority cleanup workers (USDOI, BOEMRE, 2011).

Oil Spill Trajectory Analysis

Above we have addressed the potential impacts to environmental justice during each phase of the VLOS event. In terms of oil spill trajectory analysis, previous analysis within the subsistence resources and practices section again proves instructive. Impacts on subsistence-harvest patterns and sociocultural systems directly correlate with consequent impacts on environmental justice (See Section IV.C.14, Subsistence-Harvest Patterns and IV.C.15, Sociocultural Systems). The effects described in the Subsistence-Harvest Patterns and Sociocultural Systems section would be experienced primarily by the subsistence-dependent minority Iñupiat population.

Conclusion

Environmental Justice impacts on Iñupiat Natives could occur because of their reliance on subsistence foods, and oil-spill impacts would affect subsistence resources and harvest practices, sociocultural systems, and human health. Depending on the trajectory of the VLOS, the Iñupiat communities of Barrow, Wainwright, Point Lay, and Point Hope, as well as the subsistence communities on the Russian Arctic Chukchi Sea coast, would all experience adverse impacts to varying degrees.

A very large oil spill would contaminate essential whaling areas and marine mammal harvest areas, and major effects would occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. In the event of a very large oil spill, many harvest areas and some subsistence resources would be unavailable for use. Some resource populations would suffer losses and, as a result of tainting, bowhead whales could be rendered unavailable for use. Whaling communities distant from and unaffected by potential spill effects are likely to share bowhead whale products with impacted villages. Harvesting, sharing, and processing of other subsistence resources should continue but would be hampered to the degree that these resources were contaminated. 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 and other marine mammals from an oil spill. In this manner, EJ impacts could also spread to communities outside the Chukchi Sea.

Public health impacts from a very large oil spill could be caused from contact with contaminants, which could occur mainly through inhalation, skin contact, or intake of contaminated subsistence foods; through reduced availability or acceptability of subsistence resources; through periodic interference with subsistence-harvest patterns from oil spills and oil-spill cleanup; and through stress due to fears of the long-term implications of a spill and the disruptions it would cause.

Following the EVOS, communities experienced increases in post-traumatic stress disorder, depression, anxiety, and stress (Palinkas et al., 1993; Palinkas et al., 2004), decreased social interconnectedness (or social capital) (Ritchie and Gill, 2004), and decreased subsistence harvests of many resources that persist to this day (Fall and Utermohle, 1995; Impact Assessment, Inc., 1998; Field et al., 1999; USDOI, MMS, 2003a; USDOI, BLM and MMS, 2003).

Selection of lease sale alternatives that incorporate deferral corridors along the Chukchi Sea could reduce the potential for drilling in areas closer to the Chukchi Sea shoreline. To the extent that hypothetical spills from areas within these deferral corridors exhibit higher percentages of trajectories contacting with shorelines or other areas important to subsistence harvest, selection of Alternative III or IV could slightly reduce the potential for VLOS impacts. Alternative III is most likely to reduce impacts because it incorporates the largest deferral area. As indicated in the Summary and Conclusion to the Subsistence-Harvest Patterns analysis, hypothetical spills emanating from LAs 10-13 are generally more likely to contact important areas within the eastern Chuckchi Sea and portions of western Beaufort Sea. LA9 exhibits relative higher percentages of trajectories contacting Russian subsistence areas, as compared to the rest of the proposed lease sale area.

In the event of aVLOS in the Chukchi Sea, the EJ-related impacts described above would produce disproportionate, high, adverse effects in the Iñupiat subsistence-oriented communities of Barrow, Wainwright, Point Lay, and Point Hope and in Russian subsistence communities along the Chukchi Sea coastline.

IV.E.19. Conclusion – Effects of a VLOS

If it were to occur, a low-probability VLOS event could cause significant adverse environmental impacts to most of the examined environmental resources in the Chukchi Sea region. The majority of environmental resources are anticipated to recover over the long term. However, some vulnerable animal populations could suffer lasting, population-level impacts under certain circumstances. Long-term reductions in local animal populations would exacerbate disruptions to subsistence-harvest patterns and displacement of sociocultural systems. While intervention, response and cleanup efforts could mitigate spill volume and certain environmental effects, the significant and perhaps irrevocable adverse impacts associated with a VLOS event in the Chukchi Sea highlight the need for effective spill prevention.

IV.F. Unavoidable Adverse Effects

Below is a list of resource areas that could experience unavoidable adverse effects under all of the action alternatives, with notable types of impacts in parentheses:

- water quality (various impacts associated with normal operations and potential discharges)
- air quality (small, localized impacts via normal operations)
- lower trophic level organisms (small, localized impacts via construction)
- fish resources (disturbance and localized impacts to habitat)
- Essential Fish Habitat (localized impacts from construction)
- Threatened and Endangered marine mammals (noise and disturbance)
- Threatened and Endangered marine and coastal birds (disturbance)
- marine and coastal birds (disturbance)
- other marine mammals (noise and disturbance)
- terrestrial mammals (disturbance)
- vegetation and wetlands (localized construction-related impacts)

- subsistence-harvest patterns (disturbance)
- sociocultural systems (various impacts from onshore and offshore infrastructure)
- archaeological resources (ground and seafloor-disturbing activities)
- land use plans and coastal management programs (construction)
- environmental justice (noise and general disturbance)

The natural gas development scenario would prolong oil and gas-related activities, extend the viable life of existing infrastructure, and build new facilities within previously disturbed areas. Overall, natural gas production and development would not pose any new types of impacts (short- or long-term) in addition to those posed by preceding oil activities.

A VLOS is not considered in this section because it is extremely unlikely. Adverse effects from a VLOS are not considered unavoidable.

IV.G. Relationship Between Local Short-Term Uses and Maintenance and Enhancement of Long-Term Productivity

The Sale 193 FEIS found that oil exploration, development, and production activities would entail some potential for long-term impacts to nearly all resource areas. However, in each case the potential for impacts to long-term productivity is solely derived from the risk of a large-scale oil spill. The one exception to this trend was archaeological resources. The destruction of archaeological sites and/or unauthorized removal of artifacts could occur via normal oil exploration, development, and production activities, and would represent an inherently long-term loss. The potential for such impacts exists under each action alternative.

In this Final SEIS, the natural gas development and production scenario does not involve a risk for a large oil spill. Nor does any component of the gas scenario pose new types of impacts that could adversely affect long-term productivity. None of the potential adverse impacts associated with the gas scenario (except of course for potential impacts to archaeological resources associated with ground and seafloor disturbance) would be permanent or persist past several generations.

However, a low probability VLOS event could cause long-term impacts to a variety of resource areas, including several species of fish, cetaceans, and marine and coastal birds, as well as polar bears, ice seals, walrus, subsistence harvest patterns, sociocultural systems, Environmental Justice and, again, archaeological resources. The potential for such impacts exists under each action alternative.

IV.H. 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. Holding an OCS lease sale and issuance of OCS leases do not constitute an irreversible and irretrievable commitment of resources. The OCSLA prescribes a four-stage process for the OCS program (see Figure 3, in Chapter 1). This four-stage review process gives the Secretary of the Interior a “continuing opportunity for making informed adjustments” to ensure that all OCS oil-and-gas activities are conducted in an environmentally sound manner. In the first stage, BOEMRE prepares a 5-year leasing program to identify the size, timing, and location of proposed lease sales and an EIS under NEPA. In the second stage, BOEMRE conducts the prelease process and sale-specific NEPA review. The third stage involves exploration of the leased tracts. Prior to any exploratory drilling, a lessee must submit an exploration plan (EP) to BOEMRE for review and approval. The EP must comply with the OCSLA, implementing regulations, lease provisions, and other Federal laws, and is subject to environmental review under NEPA.

Irreversible and irretrievable effects could occur only as a result in exploration, development, and production activities. Each of these activities occur at a future stage of the OCS process and would require additional NEPA review that would identify any irreversible and irretrievable commitment of resources associated with the decision at hand.

Chapter V

Cumulative Effects

CHAPTER V. Cumulative Effects

V.A. Introduction

The following subsections summarize the cumulative effects analysis from the Sale 193 FEIS, which is incorporated by reference. The analysis considers the potential effects of the proposed actions when they are added to past, present, and reasonably foreseeable activities. The summaries include a qualitative assessment of the incremental contribution of the Proposed Action to the overall cumulative effects on each resource. The incremental contribution to cumulative effects from natural gas development and production activities evaluated in this Final SEIS has been added to the cumulative impact summary for each resource. Cumulative impacts associated with the hypothetical VLOS scenario were discussed for each resource in Section IV.E, principally within Long-term Recovery subsections. For a more detailed discussion of the past, present, reasonably foreseeable, and speculative activities of the Chukchi Sea area, and the approach to the cumulative effects analysis, readers should reference Section V of the Sale 193 FEIS. There are no additional past, present, or reasonably foreseeable activities identified since the release of the Sale 193 FEIS in 2007 that would alter the analysis or conclusions therein.

V.A.1. Structure of the Analysis

The cumulative effects analysis in the Sale 193 FEIS comprised a 5-step process, which was maintained in analyzing natural gas development and production activities in this Final SEIS:

1) Analysts identified the potential effects resulting from Sale 193 on the natural resources and human environment that may occur in the Chukchi Sea and the adjacent offshore and onshore areas.

2) Analysts identified other past, present, and reasonably foreseeable future oil and gas development activity on the North Slope and adjacent offshore areas, and considered their effects on the natural resources and human environment potentially affected by Sale 193. Speculative activities were also identified and discussed. Our approach to identifying past, present, reasonably foreseeable, and speculative activities is further outlined below:

- Past oil and gas activities development and production considered in the cumulative analysis were those that resulted in currently existing infrastructure.
- Present oil and gas activities development and production considered in the cumulative analysis were those for which new facilities are under construction.
- Reasonably foreseeable oil and gas activities considered in the cumulative analysis included exploration for undiscovered resources onshore and offshore that could occur during the next 20 years, and development and production of discovered resources that are likely to occur in the next 20 years. Reasonably foreseeable activities include continued operation of the TAPS and tanker shipments of oil from Valdez, Alaska to markets in the Pacific Basin.
- Speculative oil and gas activities are those activities that may occur beyond 20 years from the present time or not at all.

3) Analysts considered effects from other actions on these same natural resources and human environments. BOEMRE considered Federal OCS activities in the Beaufort and Chukchi Sea program areas as well as BLM's continuing program of leasing in the NPR-A. It is reasonable to assume that exploration activities will continue in these Federal areas. 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 Sea coast to the Prudhoe Bay area. BOEMRE considered the State of Alaska oil- and gas-leasing plans. The State develops 10-year leasing plans and publishes a schedule every other year. All of the North Slope and Beaufort Sea commercially producible crude oil is on State leases except for a portion of the Northstar field that is in the Federal OCS. Activities other than those

associated with oil and gas that add to the environmental and sociocultural resources affected by the Proposed Action included sport and subsistence hunting and fishing, scientific surveys, and marine transportation. BOEMRE did not attempt to estimate future military activities affecting this region.

4) Analysts attempted 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) Analysts weighed 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 Sale 193 area.

Both the Sale 193 FEIS and the Final SEIS consider Arctic warming, which could contribute to cumulative effects through, among other things:

- increased noise and disturbance related to increased shipping;
- decreases in ice cover with the potential for resultant changes in prey-species concentrations and distribution with related changes in species distributions; changes in subsistence-hunting practices;
- northern expansion of species; and
- increased ocean acidity.

Rising CO2 levels in the atmosphere and corresponding increases in the CO2 levels of the waters of the world's oceans have led to the phenomenon of ocean acidification (IPCC, 2007). This phenomenon is often called a sister problem to climate change, because they are both attributed to human activities that are leading to increased CO2 levels in the atmosphere. The capacity of the Arctic Ocean to uptake CO2 is expected to increase in response to climate change (Bates and Mathis, 2009). Further, ocean acidification in high latitude seas is happening at a more advanced rate than other areas of the ocean. This is due to the loss of sea ice that increases the surface area of the Arctic seas. This exposure of cooler surface water lowers the solubility calcium carbonate, which results in lower saturation levels of calcium carbonate within the water, and in turn leads to lower available levels of the minerals needed by shell-producing organisms, such as pteropods, foraminifers, sea urchins, and molluscs (Fabry et al., 2009; Mathis, 2011).

It is possible that Arctic warming will contribute to other forms of cumulative effects as well. For instance, it has been speculated that Arctic ecosystems could become weakened and animal populations depleted and more sensitive. Diminished habitat, food resources, or population levels could all contribute to negative cumulative effects on Arctic species. However, the extent to which such effects might occur and their incremental interaction with potential effects from Lease Sale 193 activitiesdifficult to precisely forecast. BOEMRE's cumulative effects analysis has concentrated on the reasonably foreseeable factors (including those associated with Arctic warming) identified in the steps above.

The changes in incremental contributions to cumulative effects under Alternatives III and IV were not evaluated in the Sale 193 FEIS. The extended geographic scale and timeframe of the cumulative analysis reduces the sensitivity of this analysis and treatment of alternatives. Projecting future impacts on the resource further reduces the ability to detect a measurable change between the alternatives. Natural gas development and production activities would be largely identical under the action alternatives analyzed in the Sale 193 FEIS (Alternatives I, III, and IV). Differences in potential effects that may result from the deferral areas built into Alternatives II and IV are negligible.

V.A.2. General Conclusions

The bullets below summarize the general conclusions of the cumulative impacts analysis in the Sale 193 FEIS.

- 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, impacts from Sale 193 would be the primary contributor to any OCS Program impacts.
- We conclude that no significant cumulative impacts would result from routine activities associated with the Proposed Action or alternatives.
- In the event of a large offshore oil spill, biological resources may be present in the area but may not necessarily be contacted by the oil. If contacted by oil, significant adverse impacts could occur to biological resources and sociocultural systems. Some significant adverse impacts could occur to spectacled eiders, long-tailed ducks, common eiders, polar bears. Most biological resources contacted by oil are expected to recover within two to three generations.
- In the event of a large offshore oil spill, significant adverse impacts could occur to sociocultural systems. An oil spill could affect the availability of bowhead whales or other subsistence resources, or a resource might be considered tainted and unusable as a food source.
- In the event of a large offshore oil spill, significant adverse Environmental Justice effects could occur in the Iñupiat communities of Barrow, Wainwright, Point Hope, Point Lay, and Kivalina, within the North Slope Borough. If 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 Alaska Natives.

V.B. Analysis of Cumulative Effects

Natural gas development (installation of a pipeline, to shore, expansion of platform and shore facilities, and construction of a pipeline across NPR-A) and production are expected to be similar to the same activities for the earlier oil development and production. Development and production are the later phases of activities that may occur as a result of Sale 193. The effects of the installation of a natural gas pipeline to shore would be the same as those from the installation of the oil pipeline to shore. The effects of expansion of the platform and shore facilities are expected to be less than the effects of the original installations and construction because of the small scope of activity. The effects related to construction of a natural gas pipeline across NPR-A are expected to be less than those for installation of the oil pipeline across NPR-A because the access road would already exist. Accordingly, the incremental contribution of natural gas production to cumulative effects would be considerably smaller than the incremental contribution of Sale 193 as analyzed in the Sale 193 FEIS. Moreover, leasing, exploration, and oil and gas development and production would represent only a small percentage of the foreseeable cumulative activities. The incremental contribution of Sale 193 exploration, development, and production activities, including natural gas development and production, to overall cumulative effects would remain minor (in the absence of a large or very large oil spill).

Presentation of cumulative effects here follows the same organization as used in the Sale 193 FEIS, as well as Sections III and IV.C of this Final SEIS. Recent changes in ESA status do not result in changes to the organization of this section. Potential cumulative effects to the yellow-billed loon are evaluated in V.B.7, Marine and Coastal Birds. Potential cumulative effects to Pacific walrus, bearded seals and ringed seals are considered in V.B.8, Other Marine Mammals.

V.B.1. Water Quality

Current impacts to water quality in the Chukchi Sea are caused by industry, community, military, and research discharges, and naturally occurring processes. Future anthropogenic impacts to water quality would be caused primarily by effects of climate change and ocean acidification on ocean chemistry, discharge of pollution into marine waters from point-source and nonpoint-source discharges, and oil industry-related activities such as drilling operations and support vessel discharges. Polluted discharge from marine vessel traffic, oil spills, and discharges from exploration, development, production, and research activities could cause degradation of the marine environment.

Contribution of Oil Development and Production to Cumulative Impacts

Activities from Sale 193 may cause small, localized increases in the concentrations of pollutants affecting water quality. These contaminants are temporary in nature, precipitating over a small period of time after the discharges cease. Effects on local water quality are expected to be low, while regional effects are expected to be very low. Sustained degradation of water quality to contamination levels above state and federal criteria is unlikely. Compliant postlease activities do not pose a significant degree of risk to water quality. An accidental large oil spill would have possible significant impacts. The projected exploration and development from the Proposed Action would represent only a small percentage of the foreseeable cumulative activities; the contribution of the proposed action is not expected to change the level of overall cumulative effects.

Contribution of Natural Gas Development and Production to Cumulative Impacts

Effects of natural gas development and production would represent only a negligible increment to the effects from Sale 193. The incremental contribution of natural gas development and production to cumulative effects on water quality is expected to be negligible.

V.B.2. Air Quality

In the Alaska Arctic, Prudhoe Bay and Kuparuk River are the principal 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 PM_{10} (particulate matter less than 10 micrometers in diameter) are well within the National Ambient Air Quality Standards (NAAQS). 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. The air quality modeling for Liberty indicated that maximum concentrations would occur within about 100-200 meters from the facility boundary and would be considerably lower at 1 kilometer from the facility. Baseline air quality data has been collected recently in the vicinity of Wainwright and Point Lay (see for example, AECOM, Inc., 2009). It is likely that new development would be relatively scattered on the North Slope and, therefore, regional impacts would be small; higher, localized concentrations would occur in the immediate vicinity of production facilities. Based on this information, very little, if any, cumulative interaction between emissions from Sale 193 activities and other oil and gas facilities is expected.

All activities in the Chukchi Sea, Beaufort Sea, and North Slope areas of Alaska in the past and occurring now have caused little deterioration in air quality, which remains better than required by national standards. Reasonably foreseeable North Slope area activities are not expected to change this.

Arctic haze resulting from elevated concentrations of fine particulate matter occurs primarily in winter and spring. Most of these pollutants are attributed to combustion sources in Europe and Asia.

Contribution of Oil Development and Production to Cumulative Impacts

Emissions associated with routine program activities could cause small increases in onshore concentrations of some air pollutants. Emissions are not expected to exceed national or state air quality standards. In the event of a large oil spill, the concentrations of volatile organic compounds would increase rapidly near the spill site, but concentrations would dissipate rapidly and would be much reduced after the first day and there would be no major impacts.

Sale 193 activities would represent only a small percentage of the existing North Slope activity. Production from Sale 193 is likely to offset declining production elsewhere. Emissions from Sale 193 activities would have no significant cumulative effects on air quality.

Contribution of Natural Gas Development and Production to Cumulative Impacts

Effects of natural gas development and production would represent only a negligible increment to the effects from Sale 193. The incremental contribution of natural gas development and production to cumulative effects on air quality is expected to be negligible.

V.B.3. Lower Trophic Level Organisms

In the Chukchi Sea, climate change and the impacts of ocean acidification will probably have the greatest effects on lower trophic organisms through changes in sea ice cover and increased physiological stress on lower trophic populations caused by changes in water chemistry.

Contribution of Oil Development and Production to Cumulative Impacts

Offshore production-platform construction, trench dredging, and pipeline burial are expected to affect some benthic organisms within 1 km for 1 year or season. The cumulative level of effect on lower trophic level organisms with standard mitigation would be locally moderate. Contributions resulting from the proposed action are not expected to change the overall cumulative effects on lower trophic level organisms.

Contribution of Natural Gas Development and Production to Cumulative Impacts

The incremental contributions of natural gas development and production to cumulative effects on lower trophic level organisms are expected not to last more than one year or season, and to be localized and negligible.

V.B.4. Fish Resources

Subsistence fishing, coastal and maritime traffic, and any discharges from local communities have the potential to impact fish on a local level. There is no commercial fishing at this time (Arctic Fishery Management Plan, 2009) 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.

Ocean acidification is a phenomenon associated with climate change that has received recent scientific attention. This issue is described in Section III.A.2 and discussed briefly in Section V.A.1. Structure of Analysis. Fish could be affected by ocean acidification through several pathways including: reduction in calcifying organisms that are prey (e.g. pteropods for pink salmon); effects on calcium-carbonate structures in fish such as otoliths and some types of scales; alteration of carbonate-based habitats that provide structural habitat; alteration of sound propagation causing increased exposure of fish to sound; effects on the olfactory sense leading to decreased ability of fish larvae to detect adult settling sites; and acidification acting synergistically with other climate change processes in influencing the risk of dispersal of non-native invasive species.

Contribution of Oil Development and Production to Cumulative Impacts

Contributions resulting from the proposed action are not expected to change the overall cumulative effects on fish resources.

Contribution of Natural Gas Development and Production to Cumulative Impacts

Effects of natural gas development and production would represent only a negligible increment to the effects from the Sale 193. The incremental contribution of natural gas development and production to cumulative effects on fish resources is expected to be negligible.

V.B.5. Essential Fish Habitat

Subsistence fishing, coastal and maritime traffic, and discharges from local communities have the potential for local impacts on EFH. The environmental changes associated with Arctic climate change have the greatest potential to impact EFH in the Chukchi Sea region.

Contribution of Oil Development and Production to Cumulative Impacts

Contributions resulting from the proposed action are not expected to change the overall cumulative effects on EFH.

Contribution of Natural Gas Development and Production to Cumulative Impacts

Effects of natural gas development and production would represent only a negligible increment to the effects from the Sale 193. The incremental contribution of natural gas development and production to cumulative effects on EFH is expected to be negligible.

V.B.6. Threatened and Endangered Species

Threatened and Endangered Marine Mammals

Marine mammals that occur either seasonally or yearlong in the Chukchi Planning Area are subjected to potential cumulative effects found throughout their respective yearlong geographic ranges. The following sources could contribute to potential cumulative effects on marine mammals found in the Chukchi Sea Planning Area:

- subsistence hunting
- activities related to offshore oil and gas exploration and development
- marine vessel traffic
- research activities
- climate change
- pollution and contaminants

With respect to whales, available evidence indicates that subsistence hunting causes disturbance, changes in behavior, and sometimes temporary effects on habitat use, including migration paths (NMFS, 2003a). Whales avoid various industrial activities if the received sound levels associated with the activity are sufficiently strong (Richardson et al., 1995a; National Research Council, 2003a). Effects of a large oil spill in Federal or State waters would most likely result in non-lethal temporary or permanent effects on bowhead, fin, or humpback whales. It is unlikely, however, that the availability of food resources for whales would be affected. The main impacts of climate change would be related to habitat changes that might impact migratory routes and breeding, prey availability, or feeding grounds.

Bowhead Whale

The take of bowhead whales by indigenous hunters represents the largest known human-related cause of mortality in this population at the present time, and it is likely to remain so for the foreseeable future. The highly regulated subsistence take, while additive, is small and this population apparently has the capacity to absorb it and increase in abundance. Further, incidental take of bowhead whales as a result of commercial fishing, marine vessel traffic, and research activities has occurred only rarely.

Available data indicates that noise and disturbance from oil and gas exploration and development activities since the mid-1970's have had localized, short-term adverse effects, but no lasting population-level adverse effect on bowhead whales. There is no indication that human activities (other than historic commercial whaling) have caused long-term displacement in bowheads.

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. There are concerns about the effectiveness of mitigation measures being used in the Arctic (Expert Review Panel, 2010). 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. 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.

Offshore exploration seismic surveys are likely to result in some incremental cumulative effects on bowhead whales by potentially excluding whales from feeding or resting areas and disruption of important associated biological behaviors. 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. Seismic surveys, especially as mitigated under MMPA authorizations, are not expected to add significantly to the cumulative impacts on bowhead whales from past, present, and future activities.

The ice-associated bowhead may be particularly susceptible to reductions or variation in sea ice cover associated with climate change (Kovacs et al., 2010). Potential impacts may result from an increase in vessel traffic within the U. S. Chukchi Sea and Beaufort Sea, including increased shipping through the Northwest Passage and the Northern Sea Route and through the Bering Strait. Oil and gas activity in the Canadian Beaufort as well as the Russian Chukchi Sea and Northwestern Bering Sea may increase and contribute to bowhead whale exposure to human activities. Increases in vessel and industrial activities in the Russian Chukchi Sea along the northern Chukotka coast and through the Bering Strait during the fall and early winter would intensify contact with Western Arctic bowheads that concentrate there. Natural occurring events associated with climate change might manifest in shifting of geographical and later season foreign commercial fisheries operations in the northern Bering Sea that could contribute to greater exposure of bowheads to entanglement in fishing gear. Northerly shift in the distribution and abundance of pelagic fish populations and other whale species could result in greater killer whale predation and competition for prey. Subsistence hunting dynamics could also change in terms of season, bowhead availability, hunt area, methods, or equipment.

Concerns exist that ocean acidification resulting from increased concentrations of carbon dioxide may approach or exceed thresholds of tolerance for benthic organisms to assimilate calcium for protective shells and may cause interruption in the lifecycles or local abundance of zooplankton prey of bowhead and other baleen whales as well as the prey for fisheries that in turn provide a prey base for some baleen whales. The rate of change and severity of long term effects to bowhead whales would be speculative at this time.

Fin Whale

Documented human-caused mortality of fin whales in the North Pacific since the cessation of commercial whaling is low. There is no evidence of subsistence take of fin whales in the Northeast Pacific (Angliss, DeMaster, and Lopez, 2001; Angliss and Lodge, 2002). Documented fishery interaction rates with fin whales are also low in the North Pacific. Reported instances of fin whale deaths due to vessel strikes are low.

Humpback Whale

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 Ziegesar, Miller, and Dahlheim, 1994). Angliss and Lodge (2003, p. 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. During the period 2003 to 2007 there were 86 reports of human-related mortalities or injuries of central North Pacific humpback whale; 54 incidents involved commercial fishing gear, and 23 of those incidents involved serious injuries or mortalities (Allen and Angliss, 2010; Allen and Angliss, 2011). The Alaska Scientific Review Group (2001) stated that 32 humpbacks were entangled in southeast Alaska in the previous five-year period. Noise and disturbance from whale-watching boats; industrial activities; and ships, boats, and aircraft are also causes of concern for humpback whales. Vessel collision is of concern as well. 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) reported that continued development of coasts and oil exploitation and drilling may lead to humpbacks avoidance of areas.

Polar Bear

The main impacting factors of concern to polar bears (now listed as threatened under the ESA) are climate change, overharvest, and oil and fuel spills. Leads and polynas are important habitat for polar bears, especially during winter and spring, and increasing shipping traffic could disturb polar bears during these critical times (USDOI, FWS, 1995). Changes in the extent and concentration of sea ice are expected to have a significant impact on polar bears through alteration of the distribution, range, nutritional status, reproductive success, and ultimately the abundance and stock structure of polar bears (Post et al., 2009).

Contribution of Oil Development and Production to Cumulative Impacts

The Proposed Action is likely to result in a negligible contribution to effects on bowhead, fin, and humpback whales. There is the possibility of excluding whales from feeding or resting areas, and the possible disruption of important biological behaviors. The incremental contribution of the Proposed Action to cumulative effects on polar bears (now listed as threatened under the ESA) is expected to be minor, except for potential significant effects in the event of a large oil spill.

Contribution of Natural Gas Development and Production to Cumulative Impacts

Effects of natural gas development and production would represent only a small percentage of the effects from Sale 193. The incremental contribution of natural gas development and production to cumulative effects on ESA-listed marine mammals is expected to be negligible.

Threatened and Endangered Birds

The cumulative effects of the Proposed Action on threatened and endangered birds and designated critical habitat are evaluated in the Biological Evaluation prepared to meet responsibilities under the ESA.

Cumulative effects on spectacled and Steller's eiders and Kittlitz's murrelets would be similar to those identified for other similar marine and coastal bird species (below), except that the significance thresholds are different. If spectacled and Steller's eider populations continue to decline, future losses would not be recovered within a generation and would be considered a significant impact.

Contribution of Oil Development and Production to Cumulative Impacts

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 Sale 193. 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.

Contribution of Natural Gas Development and Production to Cumulative Impacts

Effects of natural gas development and production would represent only a small percentage of the effects from the Sale 193. The incremental contribution of natural gas development and production to cumulative effects on ESA-listed birds is expected to be negligible.

V.B.7. Marine and Coastal Birds

Subsistence hunting, coastwise and maritime traffic, and 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.

Contribution of Oil Development and Production to Cumulative Impacts

OCS seismic survey activities will not be allowed in the Ledyard Bay 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. Because of these measures, 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. The cumulative effect of disturbance due to seafloor sampling and drilling platforms is expected to be minor. Construction of pipelines for offshore development would impact several hundreds of acres of bird molting and foraging habitat and would be a major, but short-term, impact that would result in the displacement of staging and molting birds from nearshore areas.

Contribution of Natural Gas Development and Production to Cumulative Impacts

Effects of natural gas development and production would represent only a small percentage of the effects from the Sale 193. The incremental contribution of natural gas development and production to cumulative effects on marine and coastal birds is expected to be negligible.

V.B.8. Other Marine Mammals

Increasing human activity, industrial development, oil and gas activities, and anthropogenic and natural contaminant levels in the Arctic may be affecting marine mammal populations (Quakenbush and Sheffield, 2006). Climate change is currently having a profound impact on many Arctic marine mammal populations, particularly ice-dependent pinnipeds. The primary impacts of climate change on cetaceans are the result of habitat changes (e.g. reductions in sea ice) that may impact prey location or availability. 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 (Tynan and DeMaster, 1997), resulting in significant impacts to some species. First hand accounts suggest that such impacts may already be occurring:

> And with that global warming we have been witnessing, last fall we had thousands and thousands of walruses off our beach…about ten miles up the beach was loaded with walruses. And then when you look out – out to the ocean, there is thousands and thousands out there..And when you look out to the ocean, you know, the blue ocean, the green ocean, you would see nothing but like brown spots, brown lines in the distance, there are so many walruses out there…when they come on land, they are right next to each other, real crowded and everything. And that's how they were coming up on the beach (Ms. Marie Tracey, Pt. Lay, Alaska, June 28, 2011)

Some marine mammals 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 (Kovacs et al., 2010).

Increasing ocean acidification in the Arctic is changing the bioavailability of needed minerals for marine calcifying organisms such as phytoplankton, pteropods, and benthic invertebrates, such as mollusks (Fabry et al, 2008; Orr et al, 2005). This will result in changes in prey availability and in the nutritional value of prey for many marine mammal species, particularly walrus, bearded seals, and grey whales.

Contribution of Oil Development and Production to Cumulative Impacts

The incremental contribution of the Proposed Action to cumulative effects on marine mammals not listed under the ESA is expected to be minor, except for potential major effects in the event of a large oil spill.

Contribution of Natural Gas Development and Production to Cumulative Impacts

Effects of natural gas development and production would represent only a small percentage of the effects from the Sale 193. The incremental contribution of natural gas development and production to cumulative effects on marine mammals not listed under the ESA is expected to be negligible.

V.B.9. Terrestrial Mammals

Subsistence take, recreational hunting, and the environmental changes associated with Arctic climate change have the potential to impact terrestrial mammals to varying degrees. Industrial activities that could affect terrestrial mammals include:

- Oil and gas development in NPR-A.
- Road construction on the North Slope.
- Coal development in the Brooks Range.
- Expansion of Red Dog Mine.
- Development of bornite mining in the Ambler Mining District.

Contribution of Oil Development and Production to Cumulative Impacts

The incremental contribution of the Proposed Action to cumulative effects on terrestrial mammals is expected to be negligible to minor.

Contribution of Natural Gas Development and Production to Cumulative Impacts

Effects of natural gas development and production would represent only a small percentage of the effects from Sale 193. The incremental contribution of natural gas development and production to cumulative effects on terrestrial mammals is expected to be negligible.

V.B.10. Vegetation and Wetlands

A 2001 evaluation of cumulative impacts on the North Slope indicates that impacts on vegetation at present include approximately 17,324 acres of tundra and floodplains covered due to gravel roads, gravel pads, and gravel mining (National Research Council, 2003b). Gravel roads and gravel pads represent more than 8,800 acres and gravel mines nearly 6,400 acres of the impacted area. The indirect effects associated with existing roads, roadside flooding, dust-killed tundra, and thermokarst were estimated to cover at least 10,500 acres (National Resarch Council, 2003b). The total affected acreage is a small part of the Alaska coastal plain, and cumulative effects directly resulting from infrastructure development are probably not significant to the overall productivity of tundra plants. Impacts on vegetation could accumulate and persist, especially if the structures remain once industrial activity has ceased. Rehabilitation of gravel pads can result in the growth of grasses and sedges within 2 years after abandonment of the pads, but the natural growth of plant cover on abandoned gravel pads would be very low. 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 from dust and snowdrift accumulation or the formation and draining of impoundments related to roads and gravel pads are not considered permanent. Typically, permafrost-related geomorphic processes occurring in the North Slope create a constantly changing landscape that influences succession patterns in plant communities, so they are adapted to such frequent changes (see Section V.C.10 of the Sale 193 FEIS; USDOI, MMS, 2007a).

In terms of acres of land affected, construction of onshore infrastructure would cause more than 99% of the effects. Cumulative effects of small oil spills and other discharges are expected to be localized. 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 (see Section V.C.10 of the Sale 193 FEIS; USDOI, MMS, 2007a.

The environmental changes associated with Arctic climate change are expected to have the greatest potential to impact vegetation and wetlands on the North Slope. For example, impacts on plant communities could result in changes in diversity and abundance of plant and tree species due to increased temperatures and loss of permafrost.

Contribution of Oil Development and Production to Cumulative Impacts

A large-diameter oil pipeline is assumed to be constructed from the Chukchi Sea coast across NPR-A. The overland oil pipeline(s) would be elevated above ground and pump stations would be needed at about 100-mi intervals. Assuming that the pipeline would create an eastward corridor of about 100 ft wide and 300 mi long, the area to be impacted would be approximately 1,470 hectares (3636 acres). This 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 (25 to 30 years) of the affected plant communities.

Impacts to vegetation of Alaska's North Slope from oil and gas exploration and development in the Chukchi Sea are expected 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, nor would any effects (whether beneficial or detrimental) occur to vegetation as a result of additional acres developed.

Contribution of Natural Gas Development and Production to Cumulative Impacts

Effects of natural gas development and production would represent only a small percentage of the effects from Sale 193. The incremental contribution of natural gas development and production to cumulative effects on vegetation and wetlands is expected to be negligible.

V.B.11. Economy

Without the development of future onshore and offshore oil and gas development projects, the onshore and offshore oil industry in and near Prudhoe Bay is expected to decline, and the associated direct employment would also be expected to decline. Associated indirect employment in Southcentral Alaska, Fairbanks, and the NSB, and revenues to the Federal, State, and NSB governments would be expected to decline also.

The Trans Alaska Pipeline System (TAPS) represents a tremendous capital investment. Additional onshore and offshore oil development and production is necessary to extend the useful life of TAPS. In January 8, 2003, the TAPS right-of-way was renewed for another 30 years by both State and Federal agencies.

The northeast and northwest portions of the NPR-A are projected to generate considerable revenues in the future. Future revenues are also expected from continuing production at Prudhoe Bay and reasonably foreseeable Prudhoe Bay development.

In the Sale 193 FEIS, cumulative oil and gas activities (past, present, and reasonable foreseeable development and production, both onshore and offshore, both State and Federal) are projected to generate annual revenues of $32 million to the NSB, $232 million to the State, and $1.1 billion to the Federal government.

Cumulative gains in direct employment in the oil and gas industry would generate indirect and induced employment and associated personal income. Indirect and induced employment is generated by expenditures for goods and services used on the North Slope and spending by direct employees.

Contribution of Oil Development and Production to Cumulative Impacts

The Proposed Action is expected to have beneficial effects on the economies of the NSB, State of Alaska, and the Federal Government through the creation of direct, indirect, and induced employment and the generation of revenues. No royalties would flow to the State from Sale 193 oil production.

Oil production from Sale 193 leases would contribute to extending the useful life of TAPS.

The incremental contribution of the Proposed Action is expected to make a substantial incremental contribution to the NSB economy, a minor contribution to Alaska State economy, and a negligible contribution to National economy.

Contribution of Natural Gas Development and Production to Cumulative Impacts

Natural gas development and production would generate employment and revenues comparable to those generated by oil development and production resulting from Sale 193. No royalties would flow to the State from Sale 193 natural gas production.

Natural gas from Sale 193 leases would contribute to extending the useful life of a large capacity North Slope gas pipeline to outside markets.

Natural gas development and production is expected to have beneficial effects on the economy of the NSB, State of Alaska, and the Federal Government. The incremental contribution of natural gas development and production is expected to make a substantial incremental contribution to NSB economy, a minor contribution to Alaska State economy, and a negligible contribution to National economy.

V.B.12. Subsistence-Harvest Patterns

The NSB's written scoping comments and recommendations on the BLM's Northeast NPR-A IAP EIS in April 1997, articulated concerns about the cumulative impacts of all industrial and human activities on the North Slope and its residents. These concerns are echoed by the residents themselves:

> So I'm very concerned about how difficult our future hunters are going to have so much red tape and so much traffic from the oil industry, so much interference that our ice cellars might not get filled up (with subsistence foods). (Mrs. Doreen Lampe, Barrow, Alaska, June 27, 2011)

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 (North Slope Borough, 1997; USDOI, MMS, 2003a).

Onshore activities that could affect subsistence-harvest patterns include noise and traffic disturbance, disturbance from construction activities associated with ice roads, production facilities, pipelines, gravel mining, supply efforts, and potential oil spills. Adverse effects could include resource displacement; changes in hunter access to resources; displacement of hunters from subsistence use areas near development; increased competition; contamination levels in subsistence resources; harvest reductions; or increased effort, risk, and cost to hunters. Oil on the North Slope 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).

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. Subsistence-harvest activities could be disrupted occasionally by vessel and air traffic. 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 by requiring boat crews to travel longer distances over extended periods for hunts. 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 an entire season. 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. Required protective mitigation is expected to reduce these noise disturbance impacts.

Development of regional roads would have the potential to negatively affect wildlife and subsistence patterns through habitat fragmentation, increased access into wildlife habitats, increased disturbance impacts, increased potential for mortality (road kills), possible alteration of behavior or movement patterns of wildlife, increased competition for subsistence resources, and possibly an increase in tourist traffic and recreational use of the area. Increased access to terrestrial mammals could be associated with increases in hunting pressure and increases in competition for subsistence resources from both subsistence and nonsubsistence hunters. Increased harvest levels potentially could make game more scarce near roads. Reduced abundance and distribution of terrestrial mammals would be expected along the road corridor from hunting, trapping, recreation, and tourist traffic. As a result, subsistence 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.

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; National Research Council, 2003b; ACIA, 2004; Millennium Ecosystems Assessment, 2005; United Nations Environment Programme, 2005; Callaway, 2007). A study by Hovelsrud, McKenna and Huntington (2008) concluded that climate change was likely to change existing harvest patterns in way that would likely “decrease access to marine mammals and in ways that would increase risks and costs associated with hunting.” They predicted that less hunting was likely due to shifting marine mammal populations caused by changing sea ice conditions. This they believe would alter the “socioeconomic system of Arctic hunting communities.” They also see increased shipping and oil and gas activities as likely to increase pollution, noise, and ship strikes to whales. To them, the crucial concern is the development of an “extensive monitoring and analysis program” in order to disaggregate “local human causes from larger environmental changes” (Hovelsrud, McKenna, and Huntington, 2008). Later research by Ashjian et al. (2010), based on the collaboration of Western scientists and local whalers doing fieldwork off Barrow in 2005 and 2006, concluded that despite ongoing climate variability in the region, the area off Barrow continues to develop as a whale feeding area and the normal timing and arrival of bowheads off Barrow during their fall migration remains consistent. Thus, “the fall whale harvest by the Iñupiat community of Barrow should be relatively resilient to climate change.” Nevertheless, the “whale harvest at Barrow could… be particularly vulnerable to anthropogenic activities such as ship traffic, oil development, or an oil spill.”

Ocean acidification will be an added stressor on marine resources that are harvested for subsistence. For example, shellfish, a dietary staple of walruses, will be affected. Walruses are harvested for subsistence purposes where available, particularly from Barrow westward to include the coastal communities of Wainwright, Point Lay, and Point Hope. As another example, plankton are prey for fishes, including pink salmon (humpies), bowhead whales, and sea birds. All of these species are harvested for subsistence purposes by coastal Iñupiat of the North Slope, with the bowhead whale being of paramount importance in cultural self-definition.

Contribution of Oil Development and Production to Cumulative Impacts

Oil and gas development in the Chukchi Sea Planning Area 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 (if harvests were to be reduced or if subsistence resources were perceived to be contaminated). The use of marine subsistence resources could change if oil development reduces availability or alters distribution patterns of subsistence species. The most serious concern to Inupiat subsistence users is that potential increases in noise from OCS development could disrupt the normal migration of bowhead whales, forcing subsistence whalers into longer hunts farther from shore. The communities of Barrow, Wainwright, Point Lay, Point Hope, and Kivalina would be potentially affected; Wainwright could be the most affected community because of potential impacts from shore-base-facility construction. Applying the new significance thresholds, Wainwright may experience significant impacts through the long-term disruption of the subsistence harvest patterns.

A road associated with an oil-sales pipeline across NPR-A would provide new access to subsistence-hunting areas and subsistence resources, and subsequent concerns about increased hunting pressure and increased competition for subsistence resources from both subsistence and nonsubsistence hunters. The pipeline across NPR-A could promote the development and expansion of the oil and gas development in NPR-A, and also possible hunter access restrictions, hunting area reductions, trespass issues, and disturbance and displacement of game.

In the event that a large oil spill occurred and contaminated essential whaling areas, significant additive effects on subsistence-harvest could occur from contamination of the shoreline, tainting concerns (real or perceived effects on the quality of subsistence resources), cleanup disturbance, and disruption of subsistence practices.

Contribution of Natural Gas Development and Production to Cumulative Impacts

Natural gas development and production would represent only a small percentage of the effects of Sale 193. However, the construction of the natural gas pipeline and the expansion of the shorebase facilities could itself lead to significant impacts through the disturbance of subsistence harvest patterns for communities near the facility. The incremental contribution of natural gas development and production to cumulative effects on subsistence-harvest practices is not expected to be significant due to the existing shorebase facilities and infrastructure and its related displacement of subsistence harvest patterns, other than during the construction and expansion of the facilities.

V.B.13. Sociocultural Systems

It is important to note the difficulty in disaggregating the contribution of various factors to cumulative effects on the sociocultural systems of the North Slope communities. Many events (including ANCSA and ANILCA legislation, and the formation of the NSB, the AEWC, and other local and regional institutions) have combined with the area's oil development to bring rapid social change to the area. 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.

Contribution of Oil Development and Production to Cumulative Impacts

The effects of Sale 193 on sociocultural systems are largely the same as overall cumulative effects, except that effects of onshore support facilities are likely to be focused in Wainwright. The Proposed Action would represent a small percentage of the foreseeable cumulative activities.

Contribution of Natural Gas Development and Production to Cumulative Impacts

At Wainwright, construction activities could lead to significant effects on sociocultural systems. Regionally, the incremental contribution of Sale 193 natural gas development and production to cumulative effects would be negligible.

V.B.14. Archaeological Resources

The greatest cumulative effect on archaeological resources in the Chukchi Sea area is from natural processes such as ice gouging, bottom scour, thermokarst erosion, and shoreline erosion. Because the destructive effects of natural processes are cumulative, they have affected and will continue to affect archaeological resources in this area.

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 Federal activities. Cumulatively, these proposed projects likely would disturb the seafloor, but archaeological analyses of Pleistocene and Holocene sections of cores and remote-sensing surveys made before approval of Federal or State lease actions would be expected to keep these effects low. Federal laws would preclude effects on most historic properties from these planned activities.

Contribution of Alternative I to Cumulative Effects

The incremental contribution of the Proposed Action to cumulative impacts on both prehistoric and historic archaeological resources should be negligible. Surface- and sub-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.

Contribution of Natural Gas Development and Production to Cumulative Impacts

Gas development and production would represent only a small percentage of the effects of Sale 193. The incremental contribution of natural gas development and production to cumulative effects on archaeological resources is expected to be negligible.

V.B.15. Environmental Justice

Activities on the North Slope and in the adjacent Chukchi and Beaufort seas may affect subsistence resources and harvest practices. Environmental justice-related effects on Iñupiat Natives and the Iñupiat communities of Barrow, Wainwright, Point Lay, and Point Hope could occur because of their reliance on subsistence foods. Onshore oil and gas development, especially 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 disproportionately high, adverse effects would be expected for the Iñupiat communities of Barrow, Wainwright, Point Lay, and possibly Point Hope.

Cumulative effects on human health would derive from impacts to subsistence, degradation of air and water quality, contaminants in subsistence foods, and sociocultural effects. Long-term climate change effects on marine and terrestrial ecosystems in the Arctic—affecting subsistence resources, traditional culture, and community infrastructure of subsistence-based indigenous communities in the NSB—would be a contributing factor to cumulative environmental justice-related impacts. Potential disproportionately high adverse effects on low-income, minority populations in the region are expected to be mitigated substantially, but not eliminated.

Contribution of Alternative I to Cumulative Impacts

In-place protective measures, stipulated measures for seismic-survey permits, and mitigation accompanying NMFS IHA authorizations are expected to mitigate effects. No unmitigable adverse effects on subsistence-harvest patterns, resources, or practices (or consequent effects on sociocultural systems) would occur as a result of noise and disturbance. 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. Only in the event of a large oil spill would disproportionately high and adverse effects be expected on Alaskan Natives.

Section V.C.15 of the Sale 193 FEIS provides a discussion of the initiatives and studies that BOEMRE and other Federal, State, and NSB agencies have undertaken to address environmental justice issues on the North Slope.

Applying the revised significance threshold for Environmental Justice, significant impacts to subsistence harvest patterns and the sociocultural impacts could lead to disproportionate, high adverse effects to Wainwright.

Contribution of Natural Gas Development and Production to Cumulative Impacts

Gas development and production would continue the significant impacts to subsistence harvest patterns. Thus, the incremental contribution of natural gas development and production to cumulative effects for environmental justice issues would be significant.

Chapter VI

Consultation and Coordination

CHAPTER VI. Consultation and Coordination

VI.A. Development of the Proposed Action, DEIS, and FEIS.

In 2002, the Secretary of the Interior issued the Final OCS Oil and Gas Leasing Program for 2002-2007 (2002-2007 Five-Year Program). That document presented USDOI's decision to consider annual "special-interest" sales in the Chukchi Sea/Hope Basin OCS Planning Areas. In response to the Call For Information and Nominations published in the *Federal Register* on February 9, 2005 (70 *FR* 6903), industry nominated a substantial portion of the Chukchi Sea Planning Area. The prelease process and EIS could not be completed in time to allow the Sale during the 2002-2007 Five-Year Program, which expired on June 30, 2007. Chukchi Sale 193 was subsequently included in the 2007-2012 Five-Year Program.

Information on the prelease and NEPA processes for Sale 193 is in Sections I.D and VI of the Sale 193 FEIS. *Federal Register* Notices, Scoping Report, Draft and Final Notices of Sale, and other information on Sale 193 is on the BOEMRE website at http://alaska.boemre.gov/cproject/Chukchi193/Chukchiindex.htm.

VI.B. Development of the SEIS

On October 5, 2010, BOEMRE issued a Notice of Intent to Prepare a Supplemental Enviornmental Impact Statement (75 FR 61511). BOEMRE subsequently released a Draft SEIS, and then, a Revised Draft SEIS. Both draft documents underwent throughough public review processes, which are described in greater detail below.

Draft SEIS. The availability of the Draft SEIS was announced on October 15, 2010 (75 FR 63504) and a 45-day public review and comment period commenced. During this period, BOEMRE held six public hearings on the Draft SEIS and received more than 150,000 comments.

BOEMRE took deliberate steps to announce the availability of the Draft SEIS, to disseminate the Draft SEIS, to meet with interested parties, and to publicize the series of meetings scheduled specifically for this process. These efforts included the following:

- Publishing a Notice of Availability in the *Federal Register* on October 15, 2010.
- Updating the BOEMRE website and providing a link to the Draft SEIS.
- Mailing hard copies of the Draft SEIS to Tribal and local governments, local libraries, and other parties who expressed interest in BOEMRE NEPA documents in the past.
- Scheduling a series of meetings with both Tribal and local governments in five potentially affected villages, as well as Anchorage.
- Placing large newspaper ads to appear in two editions each of the Arctic Sounder, Fairbanks News-Miner, and Anchorage Daily News.
- Running public service messages on the two public radio stations serving the North Slope—KBRW in Barrow and KOTZ in Kotzebue—and, providing the same messages to commercial radio station KBYR (which is heard in several communities of the North Slope).
- Providing news media assignment editors with our community advisories and, thereby, the opportunity to follow up with additional announcements or stories.

Public hearings on the Draft SEIS were held in the following communities on the dates indicated: Kotzebue (November 1, 2010), Point Hope (November 2, 2010), Point Lay (November 3, 2010), Wainwright (November 4, 2010), Barrow (November 5, 2010), and Anchorage (November 9, 2010).

BOEMRE also scheduled government-to-government meetings to meet the requirements of Executive Order 13175, Consultation and Coordination with Indian Tribal Governments. The BOEMRE representative met with the Native Villages of Kotzebue, Point Lay, Wainwright, and Barrow, and with the Iñupiat Community of the Arctic Slope. No government-to-government meeting was held with the Native Village of Point Hope during the review of the Draft SEIS, because the Village had to cancel the initial meeting due to conflicts. BOEMRE offered through e-mail to reschedule the Native Village of Point Hope meeting by teleconference at the Village's earliest convenience.

BOEMRE also met with representatives from the North Slope Borough.

Revised Draft SEIS. On March 4, 2011, BOEMRE announced preparation of a Revised Draft SEIS to incorporate a VLOS analysis. Additional information on the impetus for this decision is provided in Chapter I.

The availability of the Revised Draft SEIS was announced on May 27, 2011 (76 FR 30956), and a 45-day public review and comment period commenced. During this period, BOEMRE held seven public meetings and received more than 360,000 comments. BOEMRE took deliberate steps to announce the availability of the Revised Draft SEIS, to disseminate the Revised Draft SEIS, to meet with interested parties, and to publicize the series of meetings scheduled specifically for this process. These steps mirrored those described for the Draft SEIS and also included several extra efforts (e.g. "Goldstreaking" copies of the document to coastal villages to ensure early arrival, holding meetings in Fairbanks, etc) in response to specific stakeholder requests.

Public hearings (Figure 17) on the Revised Draft SEIS were held in the following communities on the dates indicated: Kotzebue (June 21, 2011), Point Hope (June 22, 2011), Fairbanks (June 23, 2011), Barrow (June 27, 2011), Point Lay (June 28, 2011), Anchorage (June 29, 2011), and Wainwright (June 30, 2011).

BOEMRE also scheduled government-to-government meetings to meet the requirements of EO 13175. BOEMRE representative met with the Native Villages of Kotzebue, Point Hope, Barrow, Point Lay, and Wainwright; with the Iñupiat Community of the Arctic Slope; and with the Tanana Chiefs Conference.

Figure 17. Public hearing at Kotzebue (June 28, 2011).

Review of the Revised Draft SEIS

The following is a list of Federal, State, Tribal, and local government agencies; academic institutions; members of the oil and gas industry, corporations, other organizations, libraries, foreign entities, and private citizens who were sent a printed or CD copy of the Revised Draft SEIS, or were notified by a post card regarding how to obtain a copy (Table 18).

Table 18. Organizational entities and individuals who were sent a printed or CD copy of the Revised Draft SEIS, or were notified by post card regarding how to obtain a copy.

Federal – Executive Branch	
National Oceanic and Atmospheric Administration— Office of the Undersecretary **National Marine Fisheries Service**-- Regional Administrator, Alaska Bowhead Whale Project Alaska Fisheries Science Center, WA Alaska Region, Protected Resources Division **Office of Response and Restoration**-- Assessment and Restoration Division, Emergency Response Division **National Ocean Service**— Policy, Planning and Analysis Division	**Department of the Interior** Senior Advisor to the Secretary for Alaska **U.S. Fish and Wildlife Service—** Regional Office; Marine Mammals Management; Subsistence and Fisheries; Migratory Bird Management; and Endangered Species **National Park Service—** Regional Office; Subsistence Division; and Superintendent Kotzebue **Office of Environmental Policy and Compliance** **Bureau of Indian Affairs** **U.S. Geological Survey—** Alaska Science Center **Bureau of Land Management—** Alaska State Office and Northern Field Office
Department of Homeland Security-- U.S. Coast Guard, Anchorage, AK	**Department of Defense**— U.S. Army Corps of Engineers, Regulatory Branch, Alaska District
Federal – Legislative Branch	
Honorable Mark Begich, Senator	Honorable Lisa Murkowski, Senator
Honorable Don Young, US Representative	
Federal – Administrative Agencies and Other Agencies	
Marine Mammal Commission	**Environmental Protection Agency**, Office of Ecosystems; Alaska Operations Office; Region 10
U.S. Arctic Research Commission	
State of Alaska	
Office of the Governor, Washington, DC	**Department of Transportation and Public Facilities**, State Pipeline Coordinator, Joint Pipeline Office
Alaska Oil and Gas Conservation Commission	**Department of Fish and Game**, Subsistence Division; Wildlife Conservation Division;
Office of Project Management and Permitting	**Department of Community and Regional Affairs**, Commissioner
Department of Environmental Conservation	**Representative Reggie Joule**, Alaska State Legislature, Kotzebue, AK
Department of Natural Resources— Commissioner; Division of Oil and Gas; Division of Water; Citizen's Advisory Commission on Federal Areas; Division of Coastal and Ocean Management	
Tribal Governments	
Iñupiat Community of the Arctic Slope	Native Village of Point Lay
Native Village of Barrow	Native Village of Point Hope
Native Village of Kaktovik	Native Village of Shishmaref
Native Village of Kivalina	Native Village of Wainwright
Native Village of Kotzebue IRA	Native Village of Nuiqsut
Native Tribal Village of Atqasuk	
Local Governments	
Mayor, North Slope Borough	**City Manager, City of Nome**
Mayor, City of Anaktuvuk Pass	**Mayor, City of Point Hope**
Mayor, City of Barrow	**Mayor, City of Wainwright**
Mayor, City of Kaktovik	**Mayor, City of Nuiqsut**
Mayor, City of Kotzebue	**City of Kotzebue**, Planning Department

North Slope Borough— Department of Wildlife Management; Village Coordinator Anaktuvuk Pass; Planning Department Barrow; Public Information Office, Barrow; Village Coordinator, Kaktovik; Village Coordinator, Point Lay; Village Coordinator, Point Hope; Village Coordinator, Wainwright; and Village Coordinator, Atqasuk	
Organizations, Corporations, Associations, and Other Groups	
Battelle Duxbury Operations	ASRC Energy Services
American Petroleum Institute	Western GECO
National Ocean Industries Association	University of Alaska Anchorage, Institute of Social & Economic Research
Alaska Wilderness League	Alaska's "Big Village" Network
Terris, Pravik and Millian, Washington, DC	Alaska Public Radio Network
The Wilderness Society	Applied Sociocultural Research
University of Virginia, Environmental Science Department	Alaska Public Interest Research Group
Continental Shelf Associates	Alaska Marine Conservation Council
The Stephenson Group	Alaska Journal of Commerce
Continental Shelf Associates-International	Anchorage Daily News
Northwestern University, Institute for Policy Research	Alaska Newspapers Inc.
University of Louisiana Lafayette, Department of Sociology and Anthropology	LGL Alaska Research Associates Inc.
Devon Energy Production Company	Marathon Oil Company
Hess Corporation	BP Exploration (Alaska) Inc.
ExxonMobil Production Company	Union Oil Company of California
Shell Offshore Inc.	Alaska Native Science Commission
ENI Petroleum Exploration Co Inc.	Cascadia Wildlands Project
Total E&P USA Inc.	Bering Straits Coastal Resources Service Area
Petrobras America Inc	Living Resources Inc.
BHP Billiton Petroleum (Americas) Inc.	Fairbanks Daily News Miner
Murphy Exploration & Production Company	Northern Alaska Environmental Center
Anadarko Petroleum Corporation	GCI Cable TV, Barrow, AK
Texaco Inc.	Iñupiat Heritage Center, Barrow, AK
Armstrong Oil and Gas Inc.	Nunamiut Corporation, Anaktuvuk Pass, AK
Chevron USA Inc.	Nagsragmuit Tribal Council
ConocoPhillips Alaska, Inc.	Ilisagvik College
Liberty Petroleum Corp.	Barrow Whaling Captains Association
Munger Oil Information Services	News Director, KBRW News, Barrow
Sierra Club, Alaska Task Force	Alaska Eskimo Whaling Commission
North American Civil Recoveries Arbitrage Corp	Arctic Slope Regional Corporation
Belmar Engineering	Arctic Slope Native Association
University of California, School of Social Science	Ukpeagvik Iñupiat Corporation
Vaudrey & Associates Inc.	Kaktovik Iñupiat Corporation
Hanson Environmental Research Services	Alaska Clean Seas
Trustees for Alaska	Kaktovik Whaling Captains
Marine Advisory Program	NANA Regional Corporation
The Wilderness Society	Kikiktagruk Iñupiat Corporation
Exxon Valdez Oil Spill Trustee Council	Inalik Native Corporation
Alaska Inter-Tribal Council	Cully Corporation
National Wildlife Federation	Eskimo Walrus Commission
National Parks and Conservation Association	Bering Air Inc.
Cook Inlet Energy LLC	Tikigaq Corporation
Alaska Natural Heritage Program	Point Hope Whaling Captains
Alaska Support Industry Alliance	Alaska Native Knowledge Network
Guess & Rudd P.C.	Coastal Marine Institute, UAF, School of Fisheries & Ocean Sciences
Boyd, Chandler & Falconer LLP	University of Alaska Fairbanks, Geophysical Institute
Pioneer Natural Resources USA Inc.	International Arctic Research Center
National Audubon Society	Olgoonik Corporation
Sierra Club Alaska Field Office	Kuukpik Village Corporation
Alaska Conservation Foundation	Atqasuk Iñupiat Corporation
Shell Frontier Oil and Gas Inc.	World Wildlife Fund
Alaska Oil and Gas Association	Earthjustice
URS Corp	JM Walsh Company Inc
Prince William Sound Regional Citizen's Advisory Council	
Libraries	
LexisNexis Academic and Library Solutions	Kaveolook School Library, Kaktovik, AK
Amoco Production Company Library	Kiana Elementary School Library
NOAA Library	Koyuk City Library
Alaska Resources Library & Information Services	Kegoyah Kozga Public Library
University of Alaska Anchorage, Consortium Library	Tikigaq Library
Alaska Pacific University, Academic Support Center Library	University of Alaska Fairbanks, Institute of Arctic Biology

Alakanuk Public Library	University of Alaska Fairbanks, Elmer Rasmuson Library
Kenai Community Library	Ilisaavik Library, Shishmaref
Stebbins Community Library	Katie Tokienna Memorial Library
Ticasuk Library	Trapper School Community Library
Valdez Consortium Library	Juneau Public Library
Noel Wien Library	University of Alaska Southeast Library
Tuzzy Consortium Library	Alaska State Library
Foreign Entities and Individuals	
Consul, Canadian Consulate	Encana Oil and Gas (USA) Inc., Calgary, Alberta, Canada
Geological Survey of Canada, Bedford Institute of Oceanography, Dartmouth, NS, Canada	Canadian Circumpolar Library, University of Alberta, Canada
Geomarine Associates LTD, Halifax, NS, Canada	Library National Defense Research, Victoria, BC Canada
Canadian Wildlife Service, National Wildlife Research Center, Hull, PQ, Canada	RADARSAT International, Richmond, BC, Canada
Indian Affairs and Northern Development, Ottawa, ON, Canada	Department of Fisheries and Oceans, Institute of Ocean Sciences, Sidney, BC, Canada
LGL Limited Environmental Research, King City, ON, Canada	Joint Secretariat Library, Inuvikon, NT, Canada
Petro-Canada (Alaska) Inc., Calgary Alberta, Canada	Wrangel Island Nature Reserve, Moscow, Russia
Individuals	
Edward Syrjala, Centerville, MA	Reginal Aningayou, Sr., (AEWC) Gambell, AK
Chris Tompsett, Newport, RI	Merlin Koonooka, (AEWC) Gambell, AK
Kathleen Roberts, Chestertown, NY	Thomas Agiak, (AEWC) Kaktovik, AK
Dr. John Bockstoce, South Dartmouth, MA	Ida Angasan, Kaktovik, AK
Silvia Hanna, Buxton, ME	Fenton Rexford, Kaktovik, AK
Barbara Ann Dembek, East Meadow, NY	Isaac Akootchook, Kaktovik, AK
Bruce Hazen & Kimberly, Elkwood City, PA	Walt Audi, Kaktovik, AK
Robert Franz, Plymouth Meeting, PA	Nolan Soloman, Kaktovik, AK
Hyden Llewellyn, Washington, DC	George Tagarook, Kaktovik, AK
Jessica Lefevre, Alexandria, VA	Oran Knox, Sr., (AEWC) Kivalina, AK
Brenda Morgan, Winston Salem, NC	Merylin Traynor, Kaktovik, AK
Stephanie Hazlett, Westerville, OR	Raymond Hawley, (AEWC) Kivalina, AK
Wallace Taylor and Pam Mackey-Taylor, Marion, IA	Homer E. Hoogendorn, Nome, AK
James Sherrard, Plano, TX	Jeff Walters, Noorvik, AK
William Risser, MD, Houston, TX	Orville Ahkinga, Sr. (AEWC) Diomede, AK
Tony Greiner, Albuquerque, NM	Charles Menadelook (AEWC) Little Diomede, AK
K A Beckwith, Los Alamitos, CA	Jim Stimpfle, Nome, AK
Richard Charter, San Francisco, CA	Jake Koonuk, Point Hope, AK
Thomas Aldridge, San Jose, CA	Elijah Rock, Sr. (AEWC) Point Hope, AK
Chris Winter, Portland, OR	Rex Rock, Sr. (AEWC) Point Hope, AK
K A Havlena, Fort Bragg, CA	Jack Schaefer, Point Hope, AK
Carol Ampel, Medford, OR	Rex Tuzroyluke, Jr., Point Hope, AK
Chris and Amy Gulick, North Bend, WA	George Noongwook (AEWC), Savoonga, AK
Russell E. Nelson, Jr., Seattle, WA	Perry Pungowiyi (AEWC), Savoonga, AK
Jay and Sandy Lynch, Bremerton, WA	Barry Bodfish, Sr., Wainwright, AK
Stephen R. Braund, Anchorage, AK	Jack Panik (AEWC), Wainwright, AK
Rebecca Hepson, Anchorage, AK	Fredrick Ahmaogak, Wainwright, AK
Terry Cummings, Anchorage, AK	Enoch Oktollik, Wainwright, AK
John Tichotsky, Anchorage, AK	Rossman Peetook (AEWC), Wainwright, AK
Paul Davis, Anchorage, AK	Kenneth Tagarook, Wainwright, AK
Paul Gronholdt, Sand Point, AK	Harry Tazruk, Wainwright, AK
John Strasenburgh, Talkeetna, AK	Luther Komonaseak (AEWC), Wales, AK
Gordon Brower, Barrow, AK	Jacob Soolook (AEWC), Wales, AK
Johnny Adams, Barrow, AK	Archie Ahkiviana (AEWC), Nuiqsut, AK
Joseph Akpik, Barrow, AK	Sarah Kunaknony, Nuiqsut, AK
Charlotte Brower, Barrow, AK	Frank Long, Nuiqsut, AK
Martha Hopson, Barrow, AK	Gordan Matumack, Nuiqsut, AK
Joseph Upickson, Barrow, AK	Isaac Nukapigak (AEWC) Nuiqsut, AK
Wasku Williams, Barrow, AK	Emily Paniger, Nuiqsut, AK
Freddie Aishanna, Kaktovik, AK	Alice TPalook, Nuiqsut, AK
Tony Ewardson, Barrow, AK	Joeb Woodson, Nuiqsut, AK
Rosabelle Rexford, Barrow, AK	Kattanyna Bennett, Juneau, AK

VI.C. Consultation

BOEMRE has engaged in several consultation and coordination processes with other regulatory agencies in regard to proposed activities under Lease Sale 193. In terms of the NEPA process, NOAA served as a cooperating agency for the Sale 193 FEIS. NOAA is not a cooperating agency on the Sale 193 Final SEIS. However, NOAA did collaborate with BOEMRE while developing the

Revised Draft SEIS. The subsections below provide a summary of how BOEMRE has satisfied or will satisfy its requirements under various Federal regulatory processes.

VI.C.1. Endangered Species Act - Section 7 Consultation

A discussion on the Endangered Species Act (ESA) Section 7 consultation related to Sale 193 is provided in Section VI.D of the Sale 193 FEIS.

Section 7(a)(2) of the ESA requires each Federal agency to ensure that any action that they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the adverse modification of designated critical habitat. To satisfy its ESA obligations on proposed lease sales, BOEMRE consults with FWS and NMFS for listed species under each Service's jurisdiction. For ESA consultation on proposed lease sales, BOEMRE specifically requests incremental Section 7 consultation. Regulations at 50 CFR 402.14 (k) allow consultation on part of the entire action as long as that step does not violate Section 7(a)(2); there is a reasonable likelihood that the entire action will not violate Section 7(a)(2); and the agency continues consultation with respect to the entire action, obtaining a biological opinion for each step. Accordingly, at the lease-sale stage (see Figure 3 in Chapter 1 for an illustration of the four stages in OCSLA), BOEMRE consults on the early lease activities (seismic surveying, ancillary activities, and exploration drilling) to ensure that activities under any leases issued will not result in jeopardy to a listed species or cause adverse modification of designated critical habitat. BOEMRE is required to reconsult for any proposed development and production activities.

BOEMRE's predecessor agency, the MMS, prepared Biological Evaluations (BEs) that evaluated the types of activities contemplated under the Proposed Actions analyzed in the Sale 193 FEIS and this SEIS. In response to MMS requests to initiate formal consultation, both NMFS and FWS returned Biological Opinions analyzing potential oil and gas exploration, development, and production activities in the Chukchi Sea. Relevant NMFS BOs include the Arctic Regional BO of 2006 and a 2008 BO for Oil and Gas Leasing and Exploration Activities in the Beaufort and Chukchi Seas.

Subsequent to the Sale 193 FEIS, BOEMRE reinitiated ESA Section 7 consultation with both the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service. These consultations addressed new information on the occurrence of fin and humpback whales in the Chukchi Sea Planning Area, the newly listed polar bear, the yellow-billed loon as a candidate species, and updated information on ESA listed species, potential effects, and the Arctic environment. In May 2008, BOEMRE provided an updated Biological Evaluation to NMFS for consultation on bowhead, fin, and humpback whales (USDOI, MMS, 2008b). The NMFS provided their Biological Opinion to BOEMRE on July 17, 2008 (NMFS, 2008).

In July 2009, BOEMRE provided an updated Biological Evaluation to FWS for consultation on Steller's eider, spectacled eider, Kittlitz's murrelet, yellow-billed loon, and polar bear. The FWS provided their Biological Opinion to BOEMRE on September 3, 2009 (USDOI, FWS, 2009).

The FWS designated Polar Bear Critical Habitat in December 2010 (75 FR 76086) and BOEMRE has reinitiated consultation with the FWS regarding polar bear critical habitat.

The Biological Opinions and associated BEs are available at the BOEMRE website at http://alaska.boemre.gov/ref/Biological_opinions_evaluations.htm. As indicated in Table 19 (below), BOEMRE has consulted (or conferred) with the appropriate Service on the Proposed Action's potential impacts to Endangered, Threatened, and Candidate species present within the affected area, as well as regarding potential impacts to designated Critical Habitat. Moreover, BOEMRE routinely reviews and updates its Section 7 obligations to remain in compliance with the ESA.

VI.C.2. Magnuson-Stevens Fishery Conservation and Management Act Consultation

The Magnuson-Stevens Fishery Conservation and Management Act (as amended) requires Federal agencies to consult with NMFS regarding actions that may advesely affect designated Essential Fish Habitat (EFH). In 2006, BOEMRE consulted with NMFS regarding the potential effects on EFH for all five species of Pacific salmon. This process culminated in a document entitled "Chukchi Lease Sale 193 Essential Fish Habitat Consultation." In August 2009, EFH was designated for Arctic cod, saffron Cod, and opilio crab. To address EFH consultation requirements for the upcoming decision to affirm, modify, or cancel Lease Sale 193, BOEMRE submitted a separate EFH assessment and formal determination to NMFS in July, 2011.

Table 19. Consultation or conference with respect to potential impacts to Endangered, Threatened, and Candidate species present within the affected area.

Species / Critical Habitat	ESA Status	Consultations / Conferences
Bowhead Whale	Endangered	NMFS ARBO 2006**** NMFS BCS BO 2008**
Humpback Whale	Endangered	NMFS BCS BO 2008**
Fin Whale	Endangered	NMFS BCS BO 2008**
Polar Bear	Threatened	FWS BCS BO 2009*
Polar Bear – Critical Habitat	Designated	Consultation reinitiated
Spectacled Eider	Threatened	FWS Sale 193 BO 2007*** FWS BCS BO 2009
Spectacled Eider – Critical Habitat	Designated	FWS Sale 193 BO 2007*** FWS BCS BO 2009
Steller's Eider	Threatened	FWS Sale 193 BO 2007*** FWS BCS BO 2009*
Kittlitz's Murrelet	Candidate	FWS Sale 193 BO 2007*** FWS BCS BO 2009*
Yellow-Billed Loon	Candidate	FWS BCS BO 2009*
Walrus	Candidate	None
Bearded Seal	Proposed	None
Ringed Seal	Proposed	None

* FWS BCS BO 2009 = Biological Opinion for Beaufort and Chukchi Sea Program Area Lease Sales and associated Seismic Surveys and Exploratory Drilling; Fish & Wildlife Service (September 3, 2009)
**NMFS BCS BO 2008 = Biological Opinion for Oil and Gas Leasing and Exploration Activities in the Beaufort and Chukchi Seas, Alaska; and Authorizations of Small Takes Under the Marine Mammal Protection Act; National Marine Fisheries Service (July 17, 2008)
*** FWS Sale 193 BO 2007 = Biological Opinion for Chukchi Sea Planning Area, Oil and Gas Lease Sale 193 and Associated Seismic Surveys and Exploratory Drilling; Fish & Wildlife Service (March 2007)
**** NMFS ARBO 2006 = Biological Opinion for Oil & Gas Leasing & Exploration Activities in the U.S. Beaufort and Chukchi Seas, Alaska, Arctic Regional Biological Opinion; National Marine Fisheries Service (June 16, 2006)

VI.C.3. National Historic Preservation Act – Section 106 Consultation

Section 106 of the National Historic Preservation Act (NHPA) requires Federal agencies to consult with the State Historic Preservation Officer (SHPO) regarding any undertaking with the potential to affect historic properties. On January 30, 2007, BOEMRE initiated Section 106 consultation with the Alaska State Historic Preservation Officer (SHPO) for the proposed Chukchi Sea Oil and Gas Lease

Sale 193. BOEMRE identified two historic resources (shipwrecks) in the Chukchi Sea Planning Area, and identified the specific lease blocks in which these shipwrecks were located (see Sale 193 FEIS; USDOI, MMS, 2007a). At the time of the proposed lease-sale EIS, no bottom-disturbing activities were anticipated and BOEMRE requested SHPO's concurrence that proposed Lease Sale 193 would have "no effect upon known offshore historic and/or prehistoric resources." Concurrence was received from SHPO on March 2, 2007. BOEMRE has subsequently consulted with the Alaska SHPO on two additional actions relevant to the Chukchi Sea Planning Area: the Arctic Multiple-Sale DEIS in 2008 and Shell’s ancillary activity notice for marine surveys in the Chukchi Sea in 2010. While no additional Section 106 consultation will be necessary for Sale 193 or this SEIS process, additional consultations will occur regarding exploration or development plans that may follow from this sale.

VI.C.4. Coastal Zone Management Act Consistency Review

The Coastal Zone Management Act (CZMA) requires Federal agencies to insure that their activities are consistent to the maximum extent practicable with the enforceable policies of a State’s approved coastal management plan, including any enforeceable district policies. A Consistency Determination (CD) was sent to the State of Alaska in conjunction with the Proposed Notice of Sale in August 2007. The CD analyzed the consistency of Sale 193 with the Alaska Coastal Management Program (ACMP). The document evaluated potential effects from the sale action and from hypothetical exploration and development activities outlined in the FEIS analysis. The MMS (BOEMRE’s predecessor) found that the proposal was consistent to the maximum extent practicable with the State’s ACMP, including the enforceable policies of the North Slope Borough’s district plan. On October 30, 2007, the State of Alaska issued its final consistency decision concurring with our determination that the sale was consistent to the maximum extent practicable with the Alaska Coastal Management Program and the local district’s enforceable policies.

In 2011, however, the State of Alaska did not pass legislation required to extend the Alaska Coastal Management Program (ACMP), allowing the ACMP to sunset at 12:01 AM, Alaska Standard Time, on July 1, 2011. With the termination of the ACMP, there are no enforceable standards on which to base a consistency review of federal coastal development activities. No State or Federal agency will take over or assume the function and responsibilities for coastal zone management in Alaska.

VI.D. Authors, Reviewers, and Supporting Staff

BOEMRE staff with a wide variety of expertise in appropriate scientific, economic, and sociocultural disciplines contributed to the development of the SEIS and the analysis herein. Representatives from NOAA, National Marine Fisheries Service, and National Ocean Service offices also reviewed a draft document of the Revised Draft SEIS. Table 20 lists the primary individuals involved, their professional position, and their role in preparing and reviewing the SEIS.

Table 20. List of the primary individuals contributing to development and analysis in the SEIS

Name	Professional Position	Role in Preparation
Tamara Arzt	Environmental Protection Specialist	Review: T&E species, other marine mammals, economy, subsistence, harvest patterns and resources, envsociocultural systems, environmental justice, NEPA
Gene Augustine	Interdisciplinary Biologist	Review: Lower-trophic organisms; vegetation and wetlands
Scott Blackburn	Technical Writer/Editor	Document review and preparation
Christy Bohl	Oil Spill Program Adminstrator	Technical review: Oil Spill Program
Jerry Brian	Socioeconomic Specialist	Analysis: economics

Name	Professional Position	Role in Preparation
Michael Burwell	Socioeconomic Specialist	Analysis: sociocultural, subsistence, archaeological, and environmental justice
Megan Butterworth	Biological Oceanographer	Review: water quality, lower-trophic organisms, fish, Essential Fish Habitat, T&E species, other marine mammals
Chris Campbell	Sociocultural Specialist	Analysis: Sociocultural and subsistence
Mary Cody	Wildlife Biologist	Analysis: T&E species and marine mammal
Chris Crews	Wildlife Biologist	Analysis: T&E species, marine mammal, terrestrial mammal
Jim Craig, Ph.D.	Geologist	Natural gas scenario development
Deborah Cranswick	Chief, Environmental Analysis Section I	Supervisory Project Lead (for Draft SEIS); Natural gas scenario; NEPA review
Jennifer Culbertson	Biological Oceanographer	Review: water quality, lower-trophic organisms, vegetation and wetlands
Jeff Denton	Wildlife Biologist	Analysis: T&E species and marine mammals
Nancy Deschu	Fisheries Biologist	Analysis: fish, EFH, water quality
Kelly Hammerle	Environmental Protection Specialist	Review: NEPA
Dirk Herkhof	Meteorologist	Review: air quality
Kelly Hite	Environmental Protection Specialist	Review: economy, subsistence harvest patterns and resources, sociocultural systems, environmental justice, NEPA
Dan Holiday, Ph.D.	Biological Oceanographer	Analysis: lower-trophic organisms; vegetation and wetlands
Tim Holder	Sociocultural Specialist	Review and coordination between HQ and Region
Walter R. Johnson	Oceanographer	Review: Oil Spill Risk Analysis
David Johnston	Minerals Leasing Specialist	Review: Leasing process
Brian Jordan	Federal Preservation Officer and Archaeologist	Review: archaeological resources
Jim Lima, Ph.D.	Chief, Environmental Analysis Section II	Review: NEPA
Jeffery A. Loman	Deputy Regional Director	Regional management review
Jim Lusher	General Engineer	Technical review; Drilling operations
Matthew Lux	Cartographic Specialist	GIS map production
Kyle Monkelien	Petroleum Engineer	Technical review; Drilling operations
Hung Nguyen	Emergency Oil Spill Response Coordinator	Review: oil spill cleanup
Robert Peterson	Chief, Resource and Economic Analysis Section	Review: Natural gas scenario and very large oil spill scenario
Virginia Raps	Meteorologist	Analysis: climate and air quality
Michael Routhier	NEPA Coordinator	Project Lead; NEPA review
Mark Schroeder	Wildlife Biologist	Analysis: T&E species and marine and coastal birds

Name	Professional Position	Role in Preparation
Kirk Sherwood	Geologist	Technical review; VLOS scenario
Kimberly Skrupky	Marine Biologist	Review: T&E species, other marine mammals
Caryn Smith	Oceanographer	Analysis: sea ice, hydrocarbon release scenarios
Joe Talbott	NEPA Coordinator	Review: NEPA
Dennis Thurston	Geophysicist	Analysis: archaeological
Poojan B Tripathi	Environmental Protection Specialist	Review: vegetation and wetlands
Sally Valdes	Fisheries Biologist/Ecologist	Review: lower-trophic organisms, fish, Essential Fish Habitat, terrestrial mammals
James R Woehr	Avian Biologist	Review: marine and coastal birds
Eric Wolvovsky	Meteorologist	Review; air quality
Sharon Warren	Program Analysis Officer	Project Manager (Revised Draft SEIS and Final SEIS), policy coordination, and administrative record
Representatives from the NOAA, National Marine Fisheries Service and National Ocean Science offices		Review of the draft document of the Revised Draft SEIS

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Analysis of

Incomplete or Missing Information

Appendix A: Analysis of Incomplete or Missing Information

Appendix A provides an analysis of individual statements from the Sale 193 FEIS that identify incomplete or unavailable information pursuant to 40 CFR 1502.22 (regulation restated below). Although the Sale 193 FEIS is replete with discussion on the strengths and weaknesses of available data, BOEMRE analysts were generally able to complete thorough analyses and draw informed conclusions from the information available. The following analysis comprehensively addresses each item of incomplete or unavailable information.

Background

Chukchi Sea Lease Sale 193 was held in February 2008, with BOEMRE accepting high bids of approximately $2.6 billion and issuing 487 leases for approximately 2.8 million acres. As a result of a lawsuit challenging the sale, the U.S. District Court for the District of Alaska remanded Sale 193 for further NEPA analysis of three general concerns. Specifically, the Court found that the Agency failed to:

(1) analyze the environmental impact of natural gas development, despite industry interest and specific lease incentives for such development;

(2) determine whether missing information identified by the agency was relevant or essential under 40 C.F.R. § 1502.22; and

(3) determine whether the cost of obtaining the missing information was exorbitant, or the means of doing so unknown.

The first concern above is addressed within the body of the Sale 193 Revised Draft SEIS where BOEMRE has provided additional analysis on natural gas development and production. This Appendix addresses the second and third concerns by cataloguing statements within the Sale 193 FEIS that acknowledged incomplete or unavailable information, and by providing a structured analysis of those statements. The concerns articulated by the Court were evaluated sequentially in this analysis by both resource analysts and managers (see Methodology below). Briefly, information was considered *relevant* if it could be connected to reasonably foreseeable significant adverse impacts as stipulated by CEQ regulation and following the significance criteria described for each resource in the Sale 193 FEIS. All statements indicating relevant incomplete or unavailable information that would be relevant were then evaluated to determine whether the information was *essential* to a reasoned choice among alternatives. To be essential, the information must provide a means for making a clear distinction between two or more alternatives. Lastly, if missing information was determined to be relevant and essential, managers evaluated the potential means of obtaining the information to determine whether cost would be *exorbitant*.

Methodology

Appendix A catalogues all statements within the Sale 193 FEIS that acknowledged incomplete or unavailable information. This list includes statements identified by the plaintiffs in litigation as well as additional statements independently identified by BOEMRE analysts for the purpose of this analysis. Each statement of incomplete or unavailable information then underwent a robust review process to ensure consistency with 40 CFR 1502.22, the relevant text of which reads:

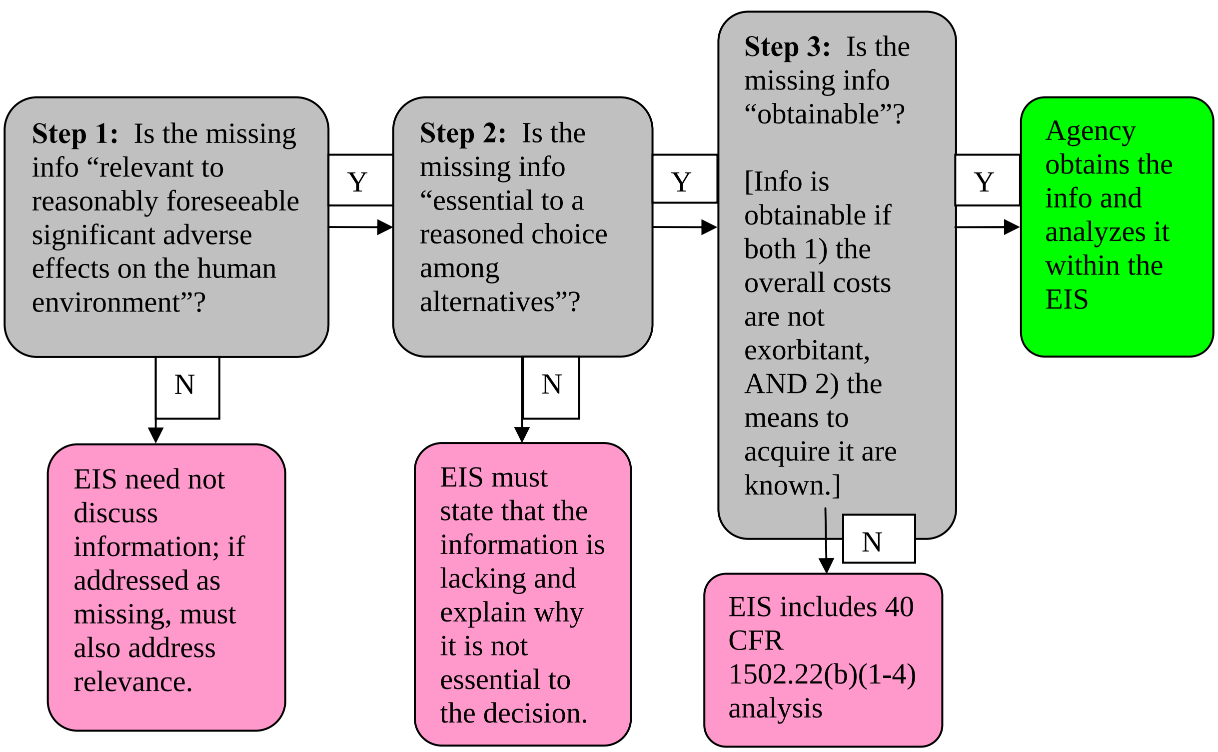
> **1502.22 Incomplete or unavailable information**.
> When an agency is evaluating reasonably foreseeable significant adverse effects on the human environment in an environmental impact statement and there is incomplete or unavailable information, the agency shall always make clear that such information is lacking.

(a) If the incomplete information relevant to reasonably foreseeable significant adverse impacts is essential to a reasoned choice among alternatives and the overall costs of obtaining it are not exorbitant, the agency shall include the information in the environmental impact statement.

(b) If the information relevant to reasonably foreseeable significant adverse impacts cannot be obtained because the overall costs of obtaining it are exorbitant or the means to obtain it are not known, the agency shall include within the environmental impact statement:

1. A statement that such information is incomplete or unavailable;
2. a statement of the relevance of the incomplete or unavailable information to evaluating reasonably foreseeable significant adverse impacts on the human environment;
3. a summary of existing credible scientific evidence which is relevant to evaluating the reasonably foreseeable significant adverse impacts on the human environment, and
4. the agency's evaluation of such impacts based upon theoretical approaches or research methods generally accepted in the scientific community. For the purposes of this section, "reasonably foreseeable" includes impacts which have catastrophic consequences, even if their probability of occurrence is low, provided that the analysis of the impacts is supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason.

To promote thorough, consistent, and efficient review of the hundreds of catalogued statements, BOEMRE analysts used a structured review approach (illustrated by the figure below). This approach, taken directly from the language of 40 CFR 1502.22, consists of three steps. Each step asks a “Yes” or “No” question, the answer to which determines whether the analysis of the statement either progresses to the next step or the statement requires no further review. Where analysts answered “Yes,” they simply moved on to the next question. Where analysts answered “No,” they recorded the reasoning behind the answer in the spreadsheet that constitutes the body of Appendix A, thus concluding review of that statement. The completed analysis for all catalogued statements was then reviewed by supervisory and staff specialists, who confirmed the analysis and determined that it satisfied 40 CFR 1502.22 (and DOI regulations for implementing NEPA at 43 CFR 46.125).



Results

BOEMRE analysts determined that while many statements of incomplete or unavailable information were broadly relevant to the important issues at hand, none were essential for a reasoned choice among alternatives. As the statements were analyzed, some common themes became apparent with respect to the catalogued statements. These included the following:

- **The availability of sufficient information to support sound scientific judgments and reasoned managerial decisions, even without the identified incomplete or unavailable information.** This concept recognizes that while there will always be some level of incomplete information (especially regarding dynamic ecosystems), there is often enough information to formulate and support sound scientific judgments. Scientists frequently agree on larger issues and trends despite the lack of a particular item of information. For example, while scientists may not know each cause of natural mortality for bowheads, it is well known (and more important) that this population as a whole is growing. Also, some information is simply not of a type that would alter scientific judgments or affect decision-making. Some information simply is not significant or relevant enough to be considered essential to a reasoned decision among alternatives. For example, additional information about the winter food habits of a whale that is only present within the action area during summer months may not be significant or relevant enough to be considered essential to a reasoned decision among alternatives.
- **The presumption that adverse effects would certainly occur under the specific circumstance to which the incomplete information applies.** For instance, it is already presumed that a large oil spill could cause significant adverse impacts to wildlife and other resources, through myriad direct and indirect effects. Thus, it is not essential for the decision-maker, who is already made aware of the probability and severity of these potential impacts, to understand every particular mechanism through which these adverse impacts could occur. Additional information specific to how spilled oil may affect the functioning of a whale's blowhole, for example, is not required for an understanding of the probability and severity of risks associated with each alternative.
- **The commonality of potential impacts amongst all action alternatives, which lessened the utility of incomplete information to the decision-maker.** For example, in the unlikely event of a large oil spill, it is well-understood that environmental impacts could be severe. The severity of potential impacts would be nearly identical under any action alternative; therefore, very specific types of information relevant to species, particular life history traits, or behavior do not help substantially in distinguishing among alternatives.
- **The existence of other environmental laws and regulations that would preclude significant adverse effects on particular resources.** For example, comprehensive regulatory standards under the Clean Air Act are sufficient to preclude air quality impacts from reaching a level of significance. Incomplete information regarding air quality issues is in this sense less useful to the decision maker, who is assured that no matter which alternative he or she selects, significant adverse effects to air quality will be avoided.
- **The understanding that certain items of presently missing or incomplete information will be known (and utilized to avoid or minimize adverse impacts) at a later stage of OCS Lands Act environmental review.** The OCS Lands Act creates a four-stage process for planning, leasing, exploration, and development and production of oil and gas resources in Federal waters. The first two stages (the 5-Year Program stage and the Lease Sale stage) are largely programmatic in nature—the pending decision pertains to Stage 2, the lease sale stage. It is inherent in the process that information such as the specific locations or times of development and production activities (proposals for which are examined in Step 4) are not known at lease sale stage (Step 2). Instead, BOEMRE would thoroughly review specific development & production plans at Step 4, if and when a project proponent actually submits a plan. Thus, while certain

information may, in fact, be essential at a later stage of OCS Lands Act, such information may not be essential to a reasoned choice among alternatives at this lease sale stage.

It should be noted that no statements written specifically for the body of the SEIS are included or analyzed within this Appendix. The SEIS is written in compliance with the requirements of 40 CFR 1502.22. The types of procedural deficiencies within the original Sale 193 FEIS that formed the basis for the second and third concerns of the District Court's remand do not recur within the SEIS. For instance, the SEIS does not include unexplained statements regarding incomplete information Four sections of the SEIS reference incomplete information "relevant to reasonably foreseeable significant adverse effects." In these sections, the SEIS follows 1502.22 by assessing whether the incomplete information is "essential to a reasoned choice among alternatives." The SEIS then provides an explanation as to why this incomplete information is not essential to a reasoned choice among alternatives, discharging the agency's 1502.22 obligations. No incomplete information pertinent to natural gas development and production progresses to step 3 of 1502.22 analysis, which would have required a determination as to "whether the cost of obtaining the missing information is exorbitant, or the means of doing so unknown."

As mentioned above, there are several environmental resource where significant adverse effects from natural gas development and productions are considered reasonably foreseeable. To illustrate how BOEMRE complies with 1502.22, consider language in the Archaeological Resources section. In Section IV.C.16, BOEMRE acknowledges that it does not possess complete information on the existence or location and characteristics of unknown archaeological resources. This "missing" information is "relevant to reasonably foreseeable significant adverse effects," given the possibility that natural gas development activities could irreversibly damage currently unknown sites, which would constitute a significant adverse effect. This "missing" information is, however, not "essential for a reasoned choice among alternatives." As the SEIS explains, potential impacts to archaeological resources are similar among all action alternatives, given that pipelines would, in each case, utilize the same existing oil infrastructure corridor; additional information on the location of archaeological resources would be gathered through required preconstruction surveys and utilized to avoid or minimize impacts during the Development & Production phase; and other environmental laws and regulations (i.e. pipeline protocols, Section 106 of the NHPA) would greatly reduce the potential for significant adverse effects under each alternative. The text of the SEIS also provides the decision-maker with comparative analysis of the slight differences between alternatives when it states: "Comparing alternatives, there is a positive correlation between the size of the area deferred from leasing and potential impacts to archaeological resources, but the overall potential for impacts remains small under each alternative." Contextualizing language is also provided in Sections IV.C.14 and IV.C.15 regarding Subsistence-Harvest Patterns and Sociocultural Systems. This language in turn contextualizes the Environmental Justice analysis. By identifying all missing information relevant to reasonably foreseeable significant adverse effects, and then explaining why the missing information is not essential to a decision among alternatives at the lease sale stage, the SEIS fully complies with 40 CFR 1502.22.

1502.22 Analysis

Page Number: ES-5

Actual Statement:

There is uncertainty about effects on cetaceans in the event of a large spill.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to adverse effects that are already assumed to occur under certain circumstances. The analysis already assumes that if a large oil spill occurs, significant impacts to cetaceans could follow. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: II-33

Actual Statement:

A review of 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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

This passage of the EIS explains that despite a diligent literature review, we were unable to identify any data that suggested seismic surveys could result in significant adverse effects to fish populations. This finding does not conclude that such studies exist. As explained in the FEIS, available scientific information is sufficient to conclude that no significant adverse effects are reasonably foreseeable (FEIS page IV-74). The lack of empirical data documenting population-level effects does not qualify as missing information relevant to reasonably foreseeable significant environmental effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: II-34

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

It is well understood that the environmental impacts associated with a large oil spill could be severe. Rare species could be affected by such an event wherever they may occur throughout the lease sale area. These impacts are explained in great detail throughout Chapter 4 of the FEIS. Overall, it is clear that: (1) no large oil spills or spill-related impacts could result from a selection of the No Action Alternative; (2) potential spill impacts (including impacts to rare or unique species) are nearly identical under each action alternative (i.e. Alternatives 1, 3 and 4.); and (3) the probability of a large spill occurring is identical under each action alternative . In light of these considerations, the decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among lease sale alternatives. The identified "incomplete information" is therefore not essential to a reasoned choice among lease sale alternatives.

Page Number: II-35

Actual Statement:

Uncertainty exists about the potential effects of seismic surveys on bowhead whales (especially on calf survival and 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 whales' reproductive status and/or sex or age.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have an unmitigable adverse impact on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project-or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from "industrial noises," BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect, as defined by the MMPA, could not rise to "significance," as defined in Section IV.A.1. of the FEIS. The FEIS anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonably foreseeable significant adverse effects. It should also be noted that the bowhead whale is protected against significant adverse effects from the Endangered Species Act.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: II-36

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

This statement offers valuable, quantitative information on whale avoidance; however, it does not indicate missing information relevant to reasonably foreseeable adverse effects on the human environment.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: II-36

Actual Statement:

The long-term response of bowheads to production facilities located at the southern end of the migration corridor is unknown.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The southern end of the bowhead migration corridor is in the Bering Sea, outside of the proposed action area. This information is not related to any reasonably foreseeable significant adverse effect on the human environment associated with this Proposed Action.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: II-36

Actual Statement:

There is uncertainty about the effects on bowheads (or any large cetacean) from the event of a large oil spill.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

These effects, as well as the probability of these effects occurring, would be the same under each action alternative. The decision-maker already has sufficient information regarding the relative probability (as between the No Action Alternative and each action alternative) and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information regarding the effects on bowheads (or any large cetacean) from the event of a large oil spill is not essential to a reasoned choice among alternatives at this stage.

Page Number: II-37

Actual Statement:

Several areas historically documented to be important to marine and coastal birds in Sale 193 area, 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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on the distribution of marine and coastal birds in the action area. However, sufficient information (population ranges, preferred habitat types, etc.) is available to support sound scientific judgments and informed decision-making at this lease sale stage, which is relatively programmatic in nature. Detailed and current information regarding specific populations at specific locations at specific times of year will be further evaluated during subsequent stages of the OCSLA process that focus on specific proposals in specific locations. In sum, this "incomplete information" is not essential to a reasoned choice among alternatives at this stage.

Page Number: II-37

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

As this general statement indicates, there will be some level of incomplete information on marine mammal ecology in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions at the lease sale stage. Activities with the potential to affect marine mammals will be subject to additional BOEMRE as well as NMFS and/or FWS review processes. Appropriate mitigation measures can and will be applied as proposals for specific activities are submitted. This multi-stage process permits more detailed review of each proposal and development of more tailored mitigation measures. Substantive and procedural requirements of the MMPA (and as applicable, the ESA) will serve to prevent significant adverse impacts. These requirements are common to all alternatives. In light of the above, any "incomplete information" regarding marine mammal ecology and specific locations of future developments is not essential to a reasoned choice between alternatives at this current stage.

Page Number: II-37

Actual Statement:

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 non-endangered and non-threatened marine mammals in the Proposed Action area.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from "industrial noises," BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: II-42

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on the distribution of marine mammals in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions at the lease sale stage. Further environmental review using site- and project-specific information will occur at later stages of the OCSLA process. Significant impacts will be avoided under all alternatives via ESA Section 7 consultation and substantive ESA and MMPA requirements. Overall, additional information on this subject is not essential for a reasoned choice among alternatives at this stage.

Page Number: II-45

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on the distribution and habitat use of marine mammals in the Chukchi Sea. However, as explained in Chapter 4 of the FEIS, much information is known. Sufficient information is available to support sound scientific judgments and reasoned managerial decisions at the lease sale stage. Additional information on these subjects is not essential to a reasoned choice among alternatives. Further environmental review using site- and project-specific information will occur at later stages of the OCSLA process. Significant impacts will be avoided under all alternatives via ESA Section 7 consultation and substantive ESA and MMPA requirements. This would occur under all alternatives -- a fact which further reduces the utility of any additional information at the current stage. In sum, additional information on this subject is not essential for a reasoned choice among alternatives.

Page Number: III-123

Actual Statement:

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. ... 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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

This missing information pertains to potential impacts to archeological resources. Detailed information on the location of archeological resources is not needed during the first two stages of OCSLA environmental review, which are largely programmatic in nature. Site-specific surveys would be required at later stages for activities with potential to disturb these resources. This is equally true for all action alternatives. Thus, this information is not essential for a reasoned choice among alternatives at the lease sale stage.

Page Number: III-123

Actual Statement:

No surveys of these shipwrecks have been made; therefore, no exact locations are known.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

Detailed information on the location of archeological resources is not needed during the first two stages of OCSLA environmental review, which are largely programmatic in nature. Site-specific surveys would be required at later stages for activities with potential to disturb these resources. This is equally true for all action alternatives. Thus, this information is not essential for a reasoned choice among alternatives at the lease sale stage.

Page Number: III-15

Actual Statement:

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

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Additional quantitative information on historical ice gouging is not relevant to any reasonably foreseeable significant adverse effects identified in the FEIS.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-22

Actual Statement:

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).

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Additional information on the frequency of noise produced by ice-deformation is not relevant to any reasonably foreseeable significant adverse effects identified in the FEIS.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-32

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on the distribution, abundance, habitat use, etc. outside of the open-water period in the Chukchi Sea. While certainly relevant in a general sense, this information is not essential to a reasoned choice among alternatives at the lease sale stage. Sufficient information on these issues is already available to support sound scientific judgments and reasoned managerial decisions regarding fish populations (see Chapters 3 and 4 of the FEIS). Given the nature of the proposed action, no significant impacts are expected to occur to these resources under any alternative. Additional, site-specific review requirements (specifically NEPA and EFH consultation) that would apply at later stages of the OCS process would identify any appropriate mitigation measures. Moreover, the missing information pertains to impacts that would be common to all action alternatives, and would be of limited utility in deciding between these options. Additional information is therefore not essential for a reasoned choice among alternatives.

Page Number: III-32

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information concerning fish population distribution, abundance, habitat use, etc. in certain areas of the Chukchi Sea. While important overall, this information is not essential to a reasoned choice among alternatives at the lease sale stage. Sufficient information is available to support sound scientific judgments and reasoned managerial decisions regarding fish populations. Given the nature of the proposed action, no significant impacts are expected to occur to these resources under any alternative. Additional, site-specific review requirements (specifically NEPA and EFH consultation) that would apply at later stages of the OCS process would identify any appropriate mitigation measures. Moreover, the missing information pertains to impacts that would be common to all action alternatives, and would not aid the decision between those alternatives. More information of this type is not essential for a reasoned choice among alternatives.

Page Number: III-33

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information concerning discrete populations of arctic fish in the action area. While important overall, this information is not essential to a reasoned choice among alternatives at the lease sale stage. Sufficient information is available to support sound scientific judgments and reasoned managerial decisions regarding fish populations. Given the nature of the proposed action, no significant impacts are expected to occur to these resources under any alternative. Additional, site-specific review requirements (specifically NEPA and EFH consultation) that would apply at later stages of the OCS process would identify any appropriate mitigation measures. Moreover, the missing information pertains to impacts that would be common to all action alternatives, and would not aid the decision between those alternatives. More information of this type is not essential for a reasoned choice among alternatives.

Page Number: III-34

Actual Statement:

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 landward of 200-m isobath, with scant surveys having sampled deeper waters. . . . [R]obust 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)…. 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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information concerning habitat-related densities, productivity rates, etc. in the action area. While important overall, this information is not essential to a reasoned choice among alternatives at the lease sale stage. Sufficient information is available to support sound scientific judgments and reasoned managerial decisions regarding fish populations. Given the nature of the proposed action, no significant impacts are expected to occur to these resources under any alternative. Additional, site-specific review requirements (specifically NEPA and EFH consultation) that would apply at later stages of the OCS process would identify any appropriate mitigation measures. Moreover, the missing information pertains to impacts that would be common to all action alternatives, and would not aid the decision between those alternatives. This information is not essential to a reasoned choice among alternatives.

Page Number: III-35

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete life history information for demersal species using neritic substrates. This information is not essential to a reasoned choice among alternatives at the lease sale stage. Sufficient information is available to support sound scientific judgments and reasoned managerial decisions regarding fish populations. Given the nature of the proposed action, no significant impacts are expected to occur to these resources under any alternative. Additional, site-specific review requirements (specifically NEPA and EFH consultation) that would apply at later stages of the OCS process would identify any appropriate mitigation measures. Moreover, the missing information pertains to impacts that would be common to all action alternatives, and would not aid the decision between those alternatives. This information is not essential to a reasoned choice among alternatives.

Page Number: III-35

Actual Statement:

No species of this assemblage are assessed as being of low resilience, because life-history data are lacking.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The absence of an indication that certain species may be less resilient does not represent missing information essential to a reasoned choice among alternatives.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-35

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on population abundance, distribution, or vulnerability for pelagic fish in the Arctic. Such baseline information is important; however, sufficient information is available to support sound scientific judgments and reasoned managerial decisions at the lease sale stage. More detailed, site-specific information would be collected at later OSCLA review stages, when project proposals and locations would be available. Furthermore, the missing information pertains to impacts that are common to all alternatives, which tends to reduce the utility of such information to the decision-maker. Overall this information is not essential to a reasoned choice among alternatives at the lease sale stage.

Page Number: III-35

Actual Statement:

The more intimate aspects of their behavior are, however, still little known….

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Information on the intimate aspects of behaviors of cryopelagic fish is not relevant to reasonably foreseeable significant adverse effects identified in the FEIS.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-36

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The proposed action would not entail any commercial fishing, and no commercial fishing occurs within the action area. The resiliency of these species to exploitation is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-36

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on the oceanic-demersal assemblage of marine fish in the Chukchi Sea. Such background information is generally relevant to impacts assessment. However, sufficient information is already available to support sound scientific judgments and reasoned managerial decisions at the lease sale stage, which is somewhat general and programmatic in nature. Given the nature of the proposed action, no significant impacts are expected to occur to these resources under any alternative. Additional, site-specific review requirements (specifically NEPA and EFH consultation) that would apply at later stages of the OCS process would identify any appropriate mitigation measures. Also, the missing information pertains to impacts that are common to all action alternatives, which further limits the utility of this information. More information of this type is not essential for a reasoned choice among alternatives.

Page Number: III-39

Actual Statement:

Little is known of the movements undertaken during the 18 months the salmon spend at sea.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

As this general statement points out, there is some level of uncertainty regarding movement patterns of juvenile pink salmon while at sea. However, sufficient information regarding the life cycle and movements of pink salmon is available to support sound scientific judgments and reasoned managerial decisions. Additional information on this issue would be of marginal utility and is not essential to a reasoned choice among alternatives.

Page Number: III-40

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of uncertainty as to the exact time period that certain salmon fry may emerge from Arctic streams along the Chukchi Sea coast. While relevant to potential impacts, this information is not essential to a reasoned choice among alternatives at the lease sale stage. Sufficient information is available to support sound scientific judgments and reasoned managerial decisions. Furthermore, the missing information pertains to impacts that are common to all alternatives. Subsequent NEPA and EFH analyses will examine these issues as necessary at a later stage of the OCSLA process, when more information regarding specific sites and activities is known. This information is not essential to a reasoned choice among alternatives at this stage.

Page Number: III-40

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on the Arctic fish population trends, population adjustments to environmental perturbations, and the relationship of the Chukchi Sea to climate change effects in North America. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions on these issues and general trends. Furthermore, the missing information pertains to impacts that are common to all alternatives, which limits the value of this information in selecting between alternatives. Overall, additional information on these subjects is not essential to a reasoned choice among alternatives.

Page Number: III-41

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on the adjustments of Arctic fish populations to changes in the distribution of their predators, prey, and competitors in the Chukchi Sea in recent years. While potentially relevant, this information is not essential for a reasoned choice among alternatives. Sufficient information is available to support sound scientific judgments and reasoned managerial decisions. Furthermore, the missing information pertains to impacts that are common to all alternatives, which reduces the value of the information in distinguishing between alternatives.

Page Number: III-42

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on population abundance, distribution, or vulnerability of marine invertebrate fisheries in specific areas within the Arctic. Such baseline information is important; however, sufficient information about these general topics is available to support sound scientific judgments and reasoned managerial decisions. Furthermore, the missing information pertains to impacts that are common to all alternatives, which limits the utility of the information to the decision-maker. Overall this information is not essential to a reasoned choice among alternatives at the lease sale stage.

Page Number: III-45

Actual Statement:

There is scientific uncertainty about the population structure of bowheads that use the Arctic Ocean.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

This statement highlights the nearly axiomatic truth that there will always be some level of scientific uncertainty regarding any dynamic population of animals. Sufficient information regarding bowhead whales is available (and analyzed in the FEIS) to support sound scientific judgments and reasoned managerial decisions, and additional information is not essential for reasoned decisions among alternatives.

Page Number: III-45

Actual Statement:

Conservation concerns include: . . uncertain potential impacts of climate warming. . ..

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

While there is some degree of unavoidable uncertainty as to the potential impacts of climate warming, much information regarding its basic mechanisms and general effects does exist and is analyzed in the FEIS. The amount and value of the information available is sufficient to support sound scientific judgments and reasoned managerial decisions. Further, the missing information applies equally to all alternatives, and would be of limited utility in distinguishing between respective levels of potential impact. For these reasons, additional information on this topic is not essential to a reasoned choice amongst alternatives.

Page Number: III-45

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The lack of an indication that human activity has had a significant adverse impact on the current status of the BCB Seas bowhead or their recovery does not qualify as missing information relevant to reasonably foreseeable adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-45

Actual Statement:

The uncertainty of the stock structure adds some uncertainty to summaries of the status of bowheads that may be impacted by the Proposed Action.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

Scientists may not be 100% certain about the best way to organize their conceptual stock structures for bowheads in the larger region. However, sufficient information exists to support sound scientific judgments and reasoned managerial decisions regarding potential impacts of the Proposed Action and alternatives on Chukchi Sea bowheads. Additional certainty on the structure of bowhead stocks is not essential to a reasoned choice among alternatives.

Page Number: III-45

Actual Statement:

Recent data to evaluate bowhead use of the Chukchi Sea Planning Area, or adjacent areas to the south, are lacking.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

As this general statement indicates, there will be some level of incomplete information on bowhead use of the Chukchi Sea and nearby areas. However, that sufficient information on these topics is available and has been analyzed. Also, activities with the potential to affect marine mammals are subject to additional BOEMRE as well as NMFS and/or FWS review processes. Appropriate mitigation measures can and will be applied as proposals for specific activities are submitted. This multi-stage process permits more detailed review of each proposal, and development of more tailored mitigation measures. As per the MMPA and ESA, significant impacts must be avoided. These procedural and substantive requirements (which would ensure that site-specific information is analyzed and that potential impacts to marine mammals do not rise to significance) would apply equally under each alternative. Thus, additional knowledge about bowhead use of these areas is not essential to a reasoned choice among alternatives at this stage of the review process.

Page Number: III-46

Actual Statement:

[I]f 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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There is some level of uncertainty regarding the speculative potential for short-term impacts to whales following hunts. However, sufficient information regarding whales' behavior, avoidance patterns, etc. are available to support sound scientific judgments and reasoned managerial decisions. It should also be noted that these possibilities have already been taken into account in the development of various alternatives and deferral areas. Enough is already known about the potential for impacts such that reasoned choices among alternatives can be made. Additional information on these issues is not essential.

Page Number: III-46

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The fin whale is known to be an occasional visitor to the action area. Sufficient information on its (limited) use of the Chukchi exists to support sound scientific judgments and reasoned managerial decisions. Additional information regarding current or historical abundance of the Northeast Pacific fin whale stock is not essential to a reasoned choice among alternatives. Moreover, the substantive and procedural requirements of the MMPA and ESA would serve to preclude significant impacts to the fin whale under each alternative.

Page Number: III-46

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

There is no connection between the missing information and reasonably foreseeable significant adverse effects associated with the Proposed Action or alternatives. The FEIS does not anticipate significant adverse effects to marine mammals outside the unlikely event of a large oil spill. Additionally, subsistence hunting would occur to the same extent under all alternatives, a fact which limits the utility of such information to the decision-maker.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-47

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The lack of data confirming presence [or absence of some specified thing] within the action area does not constitute missing information relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-48

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The lack of data confirming presence of humpback whales within the action area does not constitute missing information relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-48

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The identified population (stock) of bowhead whales is clearly identified in the 193 FEIS (page III-45) and any scientific uncertainty regarding genetic information is not relevant to reasonably foreseeable significant adverse effects identified in the 193 FEIS.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-49

Actual Statement:

There is little information regarding causes of natural mortality for BCB Seas bowhead whales.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on bowhead whale mortality; however, knowing the different ways that bowhead whales die is not as important as understanding general population trends. For bowheads, the population trend is significantly positive. Overall, sufficient information exists to support sound scientific judgments and reasoned managerial decisions. Any incomplete information on this point is not essential to a reasoned choice among alternatives. Furthermore, the missing information pertains to impacts that are common to all alternatives, and would have limited value to the decision maker in distinguishing between the respective impacts of various alternatives.

Page Number: III-49

Actual Statement:

Little is known about the effects of microbial or viral agents on natural mortality.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on the effects of microbial or viral agents on natural mortality of bowheads; however, knowing the different ways that bowhead whales die is not as important as understanding general population trends. For bowheads, the population trend is significantly positive. Overall, sufficient information exists to support sound scientific judgments and reasoned managerial decisions. Any incomplete information is not essential to a reasoned choice among alternatives. Furthermore, the missing information pertains to impacts that are common to all alternatives, and would be of limited utility in distinguishing between the respective impacts of various alternatives.

Page Number: III-49

Actual Statement:

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).

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

This data gap pertains to areas not affected by the proposed action, and is not related to any reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-50

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

While there will be some level of incomplete information on the bowhead whale use of the Chukchi Sea, BOEMRE (formerly MMS) has conducted or commissioned extensive study of bowhead use of the Chukchi Sea, and a general understanding of the bowhead migration has been accumulated. Existing information on general use and migration patterns is sufficient to support sound scientific judgments and reasoned managerial decisions, especially during the earlier stages of OCSLA review, which are necessarily more programmatic in nature. Overall, this incomplete information is not essential to a reasoned choice among alternatives.

Page Number: III-51

Actual Statement:

Data are limited on the bowhead fall migration through the Chukchi Sea before the whales move south into the Bering Sea.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

While there will be some level of incomplete information on the bowhead whale use of particular portions of the Chukchi Sea, BOEMRE (formerly MMS) has conducted or commissioned extensive study of bowhead use of the Chukchi Sea, and a general understanding of the bowhead migration (including fall migration) has been accumulated. Existing information on general use and migration patterns is sufficient to support sound scientific judgments and reasoned managerial decisions, especially during the earlier stages of OCSLA review, which are largely programmatic in nature. Overall, this incomplete information is not essential to a reasoned choice among alternatives.

Page Number: III-52

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

As this general statement indicates, there will be some level of incomplete information on bowhead feeding in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions at the lease sale stage. Activities with the potential to affect marine mammals will be subject to additional BOEMRE as well as NMFS and/or FWS review processes. Appropriate mitigation measures can and will be applied as proposals for specific activities are submitted. This multi-stage process permits more detailed review of each proposal, and development of more tailored mitigation measures. As per the MMPA and ESA, significant impacts must be avoided; these laws apply under all alternatives. In light of the above, any incomplete information regarding bowhead feeding is not essential to a reasoned choice between alternatives at the lease sale stage.

Page Number: III-53

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

As this general statement indicates, there will be some level of incomplete information on bowhead feeding needs, residency times, etc in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions at the lease sale stage. Activities with the potential to affect marine mammals will be subject to additional BOEMRE as well as NMFS and/or FWS review processes. Appropriate mitigation measures can and will be applied as proposals for specific activities are submitted. This multi-stage process permits more detailed review of each proposal, and development of more tailored mitigation measures. As per the MMPA and ESA, significant impacts must be avoided; these laws apply under all alternatives. In light of the above, any incomplete information regarding marine mammal ecology and specific locations of future developments is not essential to a reasoned choice between alternatives at the lease sale stage.

Page Number: III-54

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

While there will be some level of incomplete information on the bowhead whale use of particular portions of the Chukchi Sea, BOEMRE (formerly MMS) has conducted or commissioned extensive study of bowhead use of the Chukchi Sea, and a general understanding of bowhead migration and feeding has been accumulated. Existing information on general use and migration patterns is sufficient to support sound scientific judgments and reasoned managerial decisions, especially during the earlier stages of OCSLA review, which are largely programmatic in nature. Furthermore, the missing information pertains to potential impacts equally applicable to each action alternative, meaning that additional information on this subject is not likely to be useful to decision making at this stage. Overall, this incomplete information is not essential to a reasoned choice among alternatives.

Page Number: III-54

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

Again, there will be some level of incomplete information on bowhead feeding needs, residency times, etc in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions at the lease sale stage. Activities with the potential to affect marine mammals will be subject to additional BOEMRE as well as NMFS and/or FWS review processes. Appropriate mitigation measures can and will be applied as proposals for specific activities are submitted. This multi-stage process permits more detailed review of each proposal, and development of more tailored mitigation measures. As per the MMPA and ESA, significant impacts must be avoided; these laws apply under all alternatives. In light of the above, "incomplete information" regarding marine mammal ecology and specific locations of future developments is not essential to a reasoned choice between alternatives at the lease sale stage.

Page Number: III-55

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

While there will be some level of incomplete information on the significance of particular bowhead whale feeding areas within and near the action, BOEMRE (formerly MMS) has conducted or commissioned extensive study of bowhead use of the Chukchi Sea, and a general understanding of the bowhead migration and feeding has been accumulated. Existing information on general use and migration patterns is sufficient to support sound scientific judgments and reasoned managerial decisions, especially during the earlier stages of OCSLA review, which are necessarily more programmatic in nature. Furthermore, the missing information pertains to potential impacts equally applicable to each action alternatives, meaning that additional information on this subject is not likely to be useful to decision making at this stage. Overall, this incomplete information is not essential to a reasoned choice among alternatives.

Page Number: III-55

Actual Statement:

Recent data on distribution, abundance, or habitat use in the Chukchi Sea Planning Area are not available.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

While there will always be some lag between environmental change and available data that reflects that change, BOEMRE (formerly MMS) has conducted or commissioned extensive study of bowhead use of the Chukchi Sea, and a general understanding of the bowhead distribution, abundance, and habitat use is known. Existing information is sufficient to support sound scientific judgments and reasoned managerial decisions, especially during the earlier stages of OCSLA review, which are necessarily more programmatic in nature. Overall, this incomplete information is not essential to a reasoned choice among alternatives.

Page Number: III-56

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The fin whale is known to be an occasional visitor to the action area. Sufficient information on its (limited) use of the Chukchi exists to support sound scientific judgments and reasoned managerial decisions. Additional information regarding current or historical abundance of the Northeast Pacific fin whale stock is not essential to a reasoned choice among alternatives. Moreover, the substantive and procedural requirements of the MMPA and ESA would serve to preclude adverse impacts to the fin whale under each alternative.

Page Number: III-56

Actual Statement:

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.'

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on whale mortality. However, knowing the different ways that whales die is not as important as understanding general population trends, which are understood for all whale species that use the action area. Overall, sufficient information exists to support sound scientific judgments and reasoned managerial decisions. Incomplete information on these issues is not essential to a reasoned choice among alternatives. Furthermore, the missing information pertains to impacts that are common to all alternatives, and would not be very useful in distinguishing between the respective impacts of various alternatives.

Page Number: III-57

Actual Statement:

The importance of specific feeding areas to populations or subpopulations of fin whales in the North Pacific is not understood.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The fin whale is known to be an occasional visitor to the action area. Sufficient information on its (limited) use of the Chukchi exists to support sound scientific judgments and reasoned managerial decisions. Additional information on specific feeding is not essential to a reasoned choice among alternatives at this point in the OCSLA process, which entails more site-specific analysis at later stages. Moreover, the substantive and procedural requirements of the MMPA and ESA would serve to preclude adverse impacts to the fin whale under each alternative.

Page Number: III-57

Actual Statement:

Information is not available to us that would permit evaluation of the current use of this area by fin whales.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

Although there will be some level of incomplete information on fin whale habitat use, sufficient information is available to support sound scientific judgments and reasoned managerial decisions at the lease sale stage. It is known, for instance, that the fin whale is an infrequent though occasional visitor to certain portions of the Chukchi Sale Area. Activities with the potential to affect marine mammals will be subject to additional BOEMRE as well as NMFS and/or FWS review processes. Appropriate mitigation measures can and will be applied as proposals for specific activities are submitted. This multi-stage process permits more detailed review of each proposal, and development of more tailored mitigation measures. As per the MMPA and ESA, significant impacts must be avoided; these laws apply under all alternatives. In light of the above, additional information regarding fin whale presence/absence is not essential to a reasoned choice between alternatives at the lease sale stage.

Page Number: III-58

Actual Statement:

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 USDOI, MMS,2003a,b).

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The humpback whale is known to be a rare though occasional visitor to the action area. Sufficient information on its (limited) use of the Chukchi exists to support sound scientific judgments and reasoned managerial decisions. Additional clarity on the stock structure of the Northeast Pacific humpback whale is not essential to a reasoned choice among alternatives. Moreover, the substantive and procedural requirements of the MMPA and ESA would serve to preclude adverse impacts to humpback whales under each alternative.

Page Number: III-59

Actual Statement:

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).

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The humpback whale is known to be a rare though occasional visitor to the action area. Sufficient information on its (limited) use of the Chukchi exists to support sound scientific judgments and reasoned managerial decisions. Additional information regarding specific feeding areas and exact population counts of the Northeast Pacific humpback whale stock is not essential to a reasoned choice among alternatives. Moreover, the substantive and procedural requirements of the MMPA and ESA would serve to preclude adverse impacts to humpback whales under each alternative.

Page Number: III-59

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Additional information on which population those humpbacks that enter the Chukchi Sea belong to is not relevant to reasonably foreseeable significant adverse effects identified by the FEIS.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-59

Actual Statement:

The reliability of pre- and post-exploitation and of current abundance estimates is uncertain. … 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 post-exploitation 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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Additional information on pre- and post-exploitation and of current abundance estimates is not relevant to any reasonably foreseeable significant adverse effects identified by the FEIS.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-60

Actual Statement:

Causes of natural mortality in humpbacks in the North Pacific are relatively unknown, and rates have not been estimated.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on humpback whale mortality. However, knowing the different ways that whales die is not as important as understanding general population trends, which are understood for all whale species that use the action area. Overall, sufficient information exists to support sound scientific judgments and reasoned managerial decisions. Any incomplete information is not essential to a reasoned choice among alternatives. Furthermore, the missing information pertains to impacts that are common to all alternatives, and would have limited value in distinguishing between the respective impacts of various alternatives.

Page Number: III-62

Actual Statement:

Noting "limited data."

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on murre foraging areas in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions regarding potential impacts. Current, site-specific analysis of murre distribution and foraging areas is more feasible during later stages of OCSLA, once specific project proposals are submitted. Furthermore, the missing information largely pertains to impacts that are common to all action alternatives, and would not contribute much to a decision between them. In light of the above, any incomplete information on this subject is not essential to a reasoned choice among lease sale alternatives.

Page Number: III-62

Actual Statement:

The current status of horned puffins in the Chukchi Sea is unknown.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

This general statement points to the fact that there will always be some level of incomplete information on the past and current distribution and abundance of horned puffins in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions regarding potential impacts to this species under each alternative. Any incomplete information on these issues is therefore not essential to a reasoned choice among alternatives. It should also be remembered that subsequent environmental reviews under later OCSLA review stages will be able to consider more current information regarding specific project locations, and thus provide a more robust review than is possible at the lease sale stage.

Page Number: III-62

Actual Statement:

The current status of the tufted puffin in the Chukchi Sea is also unknown.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

This general statement points to the fact that there will always be some level of incomplete information on the past and current distribution and abundance of tufted puffins in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions regarding potential impacts to this species under each alternative. Any incomplete information on these issues is therefore not essential to a reasoned choice among alternatives. It should also be remembered that subsequent environmental reviews under later OCSLA review stages will be able to consider more current information regarding specific project locations, and thus provide a more robust review than is possible at the lease sale stage.

Page Number: III-62

Actual Statement:

In this way, horned puffins could be similar to murres, although the degree to which prey species/foraging areas overlap is unknown.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on seabird foraging areas and dietary overlap in the project area. However, sufficient information is available regarding both horned puffins and murres to support sound scientific judgments and reasoned managerial decisions for both types of birds. These species are both listed under the ESA, have been the subject of in-depth consultation with USFWS, and will be further analyzed should specific project proposals result from a lease sale. Additional information of the type referenced here is not essential to a reasoned choice among alternatives at this stage.

Page Number: III-63

Actual Statement:

The current status of the black-legged kittiwake (Rissa tridactyla) in the Chukchi Sea is unknown.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

This general statement points to the fact that there will always be some level of incomplete information on the past and current distribution and abundance of black-legged kittiwake in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions regarding potential impacts to this species under each alternative. Any incomplete information on these issues is therefore not essential to a reasoned choice among alternatives. It should also be remembered that subsequent environmental reviews under later OCSLA review stages will be able to consider more current information regarding specific project locations, and thus provide a more robust review than is possible at the lease sale stage.

Page Number: III-63

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

This general statement points to the fact that there will always be some level of incomplete information on the past and current distribution and abundance of marine and coastal bird species in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions regarding potential impacts to this species under each alternative. Any incomplete information on these issues is therefore not essential to a reasoned choice among alternatives. It should also be remembered that subsequent environmental reviews under later OCSLA review stages will be able to consider more current information regarding specific project locations, and thus provide a more robust review than is possible at the lease sale stage.

Page Number: III-63

Actual Statement:

The current status of the northern fulmar (Fulmarus glacialis) is unknown.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS analysis does not identify any reasonably foreseeable significant adverse effects on the northern fulmer. Such effects would not occur, even in the unlikely event of a large oil spill. Therefore, "missing" information on the current status of northern fulmars is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-63

Actual Statement:

The current status of the short-tailed shearwater (Puffinus tenuirostris) in the Chukchi Sea is unknown.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS analysis does not identify any reasonably foreseeable significant adverse effects on the short-tailed shearwater. Such effects would not occur, even in the unlikely event of a large oil spill. Therefore, "missing" information on the current status of short-tailed shearwaters is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-63

Actual Statement:

The current status of parakeet (Cyclorrhynchus psittacula), least (Aethia pusilla) and crested (A. cristatella) auklets in the Chukchi Sea is unknown.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS analysis does not identify any reasonably foreseeable significant adverse effects on the parakeet or least and crested auklets. Such effects would not occur, even in the unlikely event of a large oil spill. Therefore, any "missing" information on the current status of these auklets is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-63

Actual Statement:

The current status of the black guillemot (Cepphus grylle) in the Chukchi Sea is unknown.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS analysis does not identify any reasonably foreseeable significant adverse effects on the black guillemot. Such effects would not occur, even in the unlikely event of a large oil spill. Therefore, any "missing" information on the current status of black guillemots is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-64

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS analysis does not identify any reasonably foreseeable significant adverse effects on the ivory gull. Such effects would not occur, even in the unlikely event of a large oil spill. Therefore, any "missing" information on the current status of ivory gulls is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-64

Actual Statement:

The current status of the Arctic tern (Sterna paradisaea) in the Chukchi Sea is unknown.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS analysis does not identify any reasonably foreseeable significant adverse effects on the Arctic tern. Such effects would not occur, even in the unlikely event of a large oil spill. Therefore, any "missing" information on the current status of Arctic terns is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-64

Actual Statement:

The current status of the glaucous gull (Larus hyperboreus) in the Chukchi Sea is unknown.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS analysis does not identify any reasonably foreseeable significant adverse effects on the glaucous gull. Such effects would not occur, even in the unlikely event of a large oil spill. Therefore, any "missing" information on the current status of glaucous gulls is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-64

Actual Statement:

The current status of jaegers in the Chukchi Sea is unknown.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS analysis does not identify any reasonably foreseeable significant adverse effects on any species of jaegers in the Chukchi Sea. Such effects would not occur, even in the unlikely event of a large oil spill. Therefore, any "missing" information on the current status of these jaegers is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-65

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

This general statement points to the fact that there will always be some level of incomplete information on the distribution and abundance of yellow-billed loons. Although less information is known about the Chukchi coast as compared to the Beaufort coast, there still exists sufficient information overall to support sound scientific judgments and reasoned managerial decisions regarding potential impacts to yellow-billed loons under each Chukchi Sea lease sale alternative. Any incomplete information on these issues is therefore not essential to a reasoned choice among alternatives. It should also be remembered that subsequent environmental reviews under later OCSLA review stages will be able to consider more current information regarding specific project locations, and thus provide a more robust review than is possible at the lease sale stage.

Page Number: III-66

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS analysis does not identify any reasonably foreseeable significant adverse effects on the common eider. Such effects would not occur, even in the unlikely event of a large oil spill. Therefore, any "missing" information on the current status of common eiders is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-68

Actual Statement:

Pacific Brant “The current status of the Pacific brant along the Chukchi Sea is unknown.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS analysis does not identify any reasonably foreseeable significant adverse effects on the Pacific brant. Such effects would not occur, even in the unlikely event of a large oil spill. Therefore, any "missing" information on the current status of Pacific brants is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-68

Actual Statement:

The current status of greater white-fronted geese along the Chukchi Sea coast is unknown.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS analysis does not identify any reasonably foreseeable significant adverse effects on greater white-fronted geese. Such effects would not occur, even in the unlikely event of a large oil spill. Therefore, any "missing" information on the current status of greater white-fronted geese is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-68

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS analysis does not identify any reasonably foreseeable significant adverse effects on snow geese. Such effects would not occur, even in the unlikely event of a large oil spill. Therefore, any "missing" information on the current status of snow geese is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-69

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS analysis does not identify any reasonably foreseeable significant adverse effects on bar-tailed godwits. Such effects would not occur, even in the unlikely event of a large oil spill. Therefore, any "missing" information on the current status of bar-tailed godwits is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-69

Actual Statement:

The abundance and distribution of bar-tailed godwits in northern Alaska and coastal areas of the Chukchi Sea are not well understood.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS analysis does not identify any reasonably foreseeable significant adverse effects on bar-tailed godwits. Such effects would not occur, even in the unlikely event of a large oil spill. Therefore, any "missing" information on the current status of bar-tailed godwits is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-70

Actual Statement:

Buff-Breasted Sandpiper (species of concern) Noting “limited data.”

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS analysis does not identify any reasonably foreseeable significant adverse effects on the Buff-Breasted Sandpiper. Such effects would not occur, even in the unlikely event of a large oil spill. Therefore, any "missing" information on the current status of Buff-Breasted Sandpipers is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-71

Actual Statement:

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).

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on population status of ice-seals in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions. More accurate population counts and distribution predictions are not essential for a reasoned choice among alternatives at this stage. Further, this information pertains to impacts that would be common under each action alternative, a fact which further reduces the utility of this information to the decision-maker. The MMPA and its implementing regulations would ensure that potential impacts remain negligible under each alternative. The only risk for impacts above "negligible" pertains to a large oil spill, the probability of which does not differ between action alternatives.

Page Number: III-71

Actual Statement:

No reliable estimate for the size of the Alaska ringed seal stock is available (Angliss and Outlaw, 2005) . . ..

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on population status of ice-seals in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions. More accurate population counts and distribution prediction are not essential for a reasoned choice among alternatives at this stage. Also, this information pertains to impacts that would be common under each action alternative, a fact which further reduces the utility of this information to the decision-maker. The MMPA and its implementing regulations would ensure that potential impacts remain negligible under each alternative. The only risk for impacts above "negligible" pertains to a large oil spill, the probability of which does not differ between action alternatives.

Page Number: III-72

Actual Statement:

No reliable estimate for the size of the Alaska spotted seal stock is available (Angliss and Outlaw, 2005).

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on population status of ice-seals in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions. More accurate population counts and distribution prediction are not essential for a reasoned choice among alternatives at this stage. Also, this information pertains to impacts that would be common under each action alternative, a fact which further reduces the utility of this information to the decision-maker. The MMPA and its implementing regulations would ensure that potential impacts remain negligible under each alternative. The only risk for impacts above "negligible" pertains to a large oil spill, the probability of which does not differ between action alternatives.

Page Number: III-73

Actual Statement:

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).

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on the distribution and population status of ice-seals in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions. More accurate population counts and distribution predictions are not essential for a reasoned choice among alternatives at this stage. This information pertains to impacts that would be common under each action alternative, a fact which further reduces the utility of this information to the decision-maker. The MMPA and its implementing regulations would ensure that potential impacts remain negligible under each alternative. The only risk for impacts above "negligible" pertains to a large oil spill, the probability of which does not differ between action alternatives.

Page Number: III-73

Actual Statement:

No reliable estimate for the size of the Alaska ribbon seal stock is available (Angliss and Outlaw, 2005).

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on population status of ice-seals in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions. More accurate population counts and distribution prediction are not essential for a reasoned choice among alternatives at this stage. This information pertains to impacts that would be common under each action alternative, a fact which further reduces the utility of this information to the decision-maker. The MMPA and its implementing regulations would ensure that potential impacts remain negligible level under each alternative. The only risk for impacts above "negligible" pertains to a large oil spill, the probability of which does not differ between action alternatives.

Page Number: III-74

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on population status of ice-seals in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions. More accurate population counts and distribution prediction are not essential for a reasoned choice among alternatives at this stage. This information pertains to impacts that would be common under each action alternative, a fact which further reduces the utility of this information to the decision-maker. The MMPA and its implementing regulations would ensure that potential impacts remain negligible under each alternative. The only risk for impacts above "negligible" pertains to a large oil spill, the probability of which does not differ between action alternatives.

Page Number: III-74

Actual Statement:

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).

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on population status of walrus in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions. More accurate population counts are not essential for a reasoned choice among alternatives at this stage. This information pertains to impacts that would be common under each action alternative, a fact which further reduces the utility of this information to the decision-maker. The MMPA and its implementing regulations would ensure that potential impacts remain negligible under each alternative. The only risk for impacts above "negligible" pertains to a large oil spill, the probability of which does not differ between action alternatives.

Page Number: III-76

Actual Statement:

No reliable estimate for the size of the Alaska Pacific walrus stock is available (Angliss and Outlaw, 2005).

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on population status of walrus in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions. More accurate population counts and distribution prediction are not essential for a reasoned choice among alternatives at this stage. This information pertains to impacts that would be common under each action alternative, a fact which further reduces the utility of this information to the decision-maker. The MMPA and its implementing regulations would ensure that potential impacts remain negligible under each alternative. The only risk for impacts above "negligible" pertains to a large oil spill, the probability of which does not differ between action alternatives.

Page Number: III-76

Actual Statement:

The population size has never been known with certainty; however, the most recent survey estimate was approximately 201,039 animals (Gilbert et al., 1992).

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on population status of walrus in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions. More accurate population counts and distribution prediction are not essential for a reasoned choice among alternatives at this stage. This information pertains to impacts that would be common under each action alternative, a fact which further reduces the utility of this information to the decision-maker. The MMPA and its implementing regulations would ensure that potential impacts remain negligible under each alternative. The only risk for impacts above "negligible" pertains to a large oil spill, the probability of which does not differ between action alternatives.

Page Number: III-76

Actual Statement:

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).

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Lack of information specific to the potential "significance" of two beluga stocks occurring at the same place at similar times during the fall migration does not constitute missing information relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-77

Actual Statement:

Winter food habits of belugas are largely unknown; ...

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Belugas move out of the project area during the winter, into Russian waters and the Bering Sea. The feeding habits of beluga during these times is not related to any reasonably foreseeable adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-77

Actual Statement:

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).

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on the seasonal distributions, including feeding areas, of belugas in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions. Additional NEPA review processes will take into account project details and specific locations. Also, substantive provisions of the MMPA would protect the beluga under all alternatives. In light of these considerations, additional information on beluga migration patterns is not essential to a reasoned choice among alternatives at this time.

Page Number: III-78

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on population status of minke whales in Alaska waters. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions. More accurate counts are not essential for a reasoned choice among alternatives. Furthermore, the missing information pertains to impacts that are common to all alternatives, limiting the utility of this information to the decision maker.

Page Number: III-78

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Lack of biological data to support subdividing the harbor porpoise population into separate stocks does not qualify as missing information relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-81

Actual Statement:

The maximum reproductive age for polar bears is unknown, but is likely well into their 20's (Amstrup, 2003).

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

Sufficient information regarding the general reproductive capacity of polar bears is known to support sound scientific judgments and reasoned managerial decisions. Additional information on the maximum reproductive age for polar bears is not essential for a reasoned choice among alternatives.

Page Number: III-84

Actual Statement:

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).

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on population status of polar bears in the Chukchi and Bering Seas. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions. More accurate counts are not essential for a reasoned choice among alternatives. Furthermore, the missing information pertains to impacts that are common to all alternatives, limiting the utility of this information to the decision maker.

Page Number: III-84

Actual Statement:

[W]ith 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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The exact size of illegal harvest of polar bears in Russia is not related to any component of the proposed action or relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: III-84

Actual Statement:

[B]ecause 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).

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on the exact amount of illegal take of polar bear. However, specialists have agreed to a population size and trend for management purposes. Such information was used to support sound scientific judgments and reasoned managerial decisions. Additional data regarding illegal take is not essential for a reasoned choice among alternatives. Furthermore, missing information pertains to activities outside the scope of the Proposed Action, and potential impacts are common to all alternatives, which limits the utility of this information to the decision maker.

Page Number: III-88

Actual Statement:

The number of muskoxen that occur within the Proposed Action is unknown.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

There is no potential for significant adverse effects to muskoxen. More specific information on the number of muskoxen within the Proposed Action area is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-32

Actual Statement:

Direct estimates or measurements of total recoverable concentrations of metals in discharged drilling muds are not available.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

As explained in the FEIS, there is no reasonably foreseeable potential for the discharge of drilling muds to cause significant adverse effects. Additional information on metal concentrations is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

Page Number: IV-51

Actual Statement:

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. (see #3 above)

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The absence of data demonstrating population-level impacts does not constitute missing information relevant to reasonably foreseeable significant adverse impacts.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-54

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The lack of data demonstrating a major effect does not qualify as missing information relevant to reasonably foreseeable significant adverse effects. The FEIS did not identify a possibility of significant adverse effects from these identified activities.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-60

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that if oil contacted spawning locations, significant impacts would occur. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. Additional information on the myriad potential mechanisms of effect, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-61

Actual Statement:

A number of diadromous species in the region have complicated life-history patterns that are not fully understood.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete understanding of the complicated life histories of diadromous fish species in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions. Additional information is not essential to a reasoned choice among alternatives.

Page Number: IV-61

Actual Statement:

Effects on recruitment would be particularly difficult to assess, because very few studies of offshore fishes have been made.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on the recruitment patterns of all fishes in offshore areas of the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions. Under each alternative, additional review processes (e.g., NEPA during subsequent OCSLA stages, and EFH consultation) will utilize site- and project-specific analysis to identify any appropriate mitigation measures. Thus additional information on recruitment patterns of offshore fish is not essential to a reasoned choice among alternatives at this stage of the process.

Page Number: IV-62

Actual Statement:

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 lifehistory 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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on the association of juvenile arctic cod and sea ice, especially as it pertains to survival and recruitment, in the Chukchi Sea. While potentially important, this information is not essential to a reasoned choice among alternatives at this time. Sufficient information is available to support sound scientific judgments and reasoned managerial decisions. Additional review processes (NEPA, EFH) would take into account the more detailed site and project information which would be available at that time.

Page Number: IV-63

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on the a distribution and abundance of capelin spawning sites along the coast of the Chukchi Sea. This level of available information is sufficient to support sound scientific judgments and reasoned managerial decisions, even in the absence of additional data of this type. Additional review processes (NEPA, EFH) would take into account the more detailed site and project information which would be available at that time.

Page Number: IV-67

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

There is no connection between the uncertainty about the mechanism for the apparent decline in smolt abundance observed in a southern portion of Alaska and any reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-72

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The lack of an indication that any small oil spills going unreported may or may not be causing impacts does not qualify as missing information relevant to reasonably foreseeable adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-74

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The absence of data demonstrating population-level impacts does not constitute missing information relevant to reasonably foreseeable significant adverse impacts.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-74

Actual Statement:

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

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The absence of data demonstrating population-level impacts does not constitute missing information relevant to reasonably foreseeable significant adverse impacts.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-81

Actual Statement:

Absent direct information on potential effects on baleen calves, we draw on more general mammalian literature about potential effects on very young individuals.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on the potential effects of oil on baleen whale calves in the project area. Such information is important; however, sufficient information (specifically the wealth of mammalian literature referenced for this analysis) is available to support sound scientific judgments and reasoned managerial decisions. Direct information on potential effects to baleen calves is not essential for a reasoned choice among alternatives at this stage. Further, impacts will be reduced and/or precluded through additional, site-specific review and ESA Section 7 consultation in the future.

Page Number: IV-82

Actual Statement:

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 scientific uncertainty about the potential effects of noise, especially repeated exposure to loud noise, on baleen whales (NRC, 2003, 2005; minutes from meetings of the Marine Mammal Commission Sound Advisory Panel, 2004, 2005 from their web site). 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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The first half of this statement contains general language which demonstrates some of the benefits of conducting multi-stage environmental review as per the four-stage OCSLA process. This information, while not essential at this stage, will be used at later stages to inform detailed environmental reviews and avoid impacts. The second half of this statement contains general language highlighting points of uncertainty within current science regarding whales and potential impacts to whales. There will be some level of incomplete information on the potential effects of oil exploration and development activities on baleen whales, including bowhead whale calves, in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions. Also, additional review processes (i.e. ESA Section 7 consultation, etc.) will help ensure lack of significant impacts to these animals. Thus additional information is not essential to a reasoned choice among alternatives. Also, it should be noted that the only component of the Proposed Action that could significantly effect whales is the small risk of a large oil spill. The probability of such an event is the same under all action alternatives, which limits the utility of this information to the decision maker.

Page Number: IV-86

Actual Statement:

[T] here 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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects. It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-86

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects. (It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.)

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-87

Actual Statement:

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).

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects. (It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.)

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-87

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects. (It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.)

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-87

Actual Statement:

...even though there are no direct data from hearing tests on any baleen whale.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects. It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-88

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects. It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-88

Actual Statement:

There are no data on which to determine the kinds or intensities of sound that could cause a TTS in a baleen whale.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects. It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-88

Actual Statement:

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-thresholdshift and TTS damage to the ear. Whether similar age-related damage occurs in cetaceans is unknown.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects. It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-88

Actual Statement:

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).

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects. It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-89

Actual Statement:

Long-term impacts of OCS seismic-survey noise on the hearing abilities of individual marine mammals are unknown…

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects. It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-89

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects. It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-89

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects. It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-89

Actual Statement:

It is not known whether (or which) marine mammals can . . . and do adapt their vocalizations to background noise.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects. It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-92

Actual Statement:

No information was available regarding the time required for these whales to return to normal behavior.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects. It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-97

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects. (It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.)

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-117

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that a large oil spill would lead to significant impacts. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-118

Actual Statement:

The potential effect of crude oil on the function of the cetacean blowhole is unknown.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that if oil contacted cetacean blowholes, significant impacts would occur. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-118

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that if oil were ingested by bowheads, significant impacts would occur. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-118

Actual Statement:

It is not known if bowheads would leave a feeding area where prey was abundant following a spill.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to one of many varieties of potential adverse effects that the analysis already assumes could occur under certain circumstances. The analysis assumes that significant impacts could occur regardless of whether bowheads leave a feeding area where prey was abundant following a spill. Neither the probability nor severity of these impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-118

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that a large oil spill would lead to significant impacts. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-118

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that a large oil spill would lead to significant impacts. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-118

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that a large oil spill would lead to significant impacts. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-119

Actual Statement:

The potential effects to bowheads of exposure to PAC's through their food are unknown.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

There is no connection between the potential adverse impact and the action alternatives. Bowheads can accumulate PACs through their foods across their entire range over their entire lifetime regardless of the lease sale decision. The Proposed Action would not contribute appreciably to contamination of bowheads. This information, therefore, is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-120

Actual Statement:

There is a paucity of information about whether bowhead whales may be temporarily displaced from areas affected by an oil spill or cleanup operations.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that a large oil spill would lead to significant impacts. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-121

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that if spilled oil entered the spring lead and polynya systems, significant impacts could occur. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-121

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that if oil contacted newborn, calf, near-term, or post-partum whales, then significant impacts would occur. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-121

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that a large oil spill would lead to significant impacts. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-121

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that a large oil spill would lead to significant impacts. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-122

Actual Statement:

[I]t 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 be 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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that a large oil spill would lead to significant impacts. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-122

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that a large oil spill would lead to significant impacts. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-122

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The lack of data indicating that a population level effect could occur does not qualify as missing information relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-123

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS analysis concludes that the only potential cause of significant adverse effects to marine mammals from the Proposed Action would be a large oil spill. Potential impacts from development would not rise to a level of "significant adverse." Additional data on bowhead response to construction in high use areas would not be relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-123

Actual Statement:

The observed response of bowhead whales to seismic noise has varied among studies. The factors associated with variability are not entirely clear.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative (including seismic activities) would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorization generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects. It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-125

Actual Statement:

In conclusion, there is uncertainty about effects on bowheads (or any large cetacean) in the event of a large oil 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 very large amount of fresh crude oil.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that a large oil spill would lead to significant impacts. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-125

Actual Statement:

There is great uncertainty about the effects of fresh crude oil on cetacean calves.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that a large oil spill would lead to significant impacts. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-126

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

While site-specific data on habitat use patterns, routes and timing are certainly useful in assessing impacts, this information is not essential to a reasoned choice among alternatives in this case and at this stage of the decision-making process. Much information is already known on the general habits of the many species of birds that use the Chukchi Sea. This level of available information is sufficient to support sound scientific judgments and reasoned managerial decisions, even in the absence of additional data of this type. The protections that these birds receive under the MBTA (and for some species, the ESA) will serve to preclude or reduce impacts. Also, one should remember the 4-stage OCSLA process at work here. The current decision to be made is at step 2 of the process, the lease sale stage, which is relatively programmatic in nature. Certain site- and project-specific details can only be known at later steps in this process. Any appropriate additional mitigation measures can and will be developed at those later stages, when important information about project locations and details can be known.

Page Number: IV-127

Actual Statement:

Few studies have assessed the effects of seismic surveys on marine birds and waterfowl.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

This item does not identify any missing information relevant to reasonably foreseeable significant adverse effects. A low number of studies on an issue does not equate to missing information.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-127

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS's thorough analysis of potential impacts to birds, including birds that engage in diving, indicated that use of airguns did not pose the potential for any significant adverse effects. Additional information on the threshold for physiological damage to diving birds is therefore not relevant to any reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-127

Actual Statement:

Therefore, it is unclear whether changes in diving frequency were due to disturbance from seismic vessels or local abundance of prey items.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS analysis does not identify any reasonably foreseeable significant adverse effects from disturbance of diving frequency. Uncertainty as to whether changes in diving frequency could be from seismic vessels or local abundance of prey items is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-130

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS analysis does not identify any reasonably foreseeable significant adverse effects from disturbance of diving activities. Additional data regarding bird behavior around (specifically) drill ships is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-130

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

While the location of such facilities could potentially be relevant to reasonably foreseeable significant adverse effects, the structure of the 4-stage OCSLA review process is such that the specific locations of potential facilities cannot be known at this point in time. Once identified during a later review stage, this information will be used to inform site-specific reviews and to reduce and/or avoid adverse impacts. This process would apply under each action alternative. In sum, specific locations of future facilities are not essential to a reasoned choice among alternatives at this stage, which is more programmatic in nature.

Page Number: IV-132

Actual Statement:

The current distribution and abundance of these predators along the Chukchi Sea coast are unknown.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS's thorough analysis of potential impacts to birds did not identify predators as a potential source of significant adverse effects. Additional information on the distribution and abundance of bird predators along the Chukchi coast is therefore not relevant to any reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-133

Actual Statement:

It is unknown if exposed adults could become permanently sterilized.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that a large oil spill would lead to significant impacts. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on whether exposed adult birds could become permanently sterilized is not essential to a reasoned choice among alternatives.

Page Number: IV-133

Actual Statement:

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 immuno-suppression 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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

This piece of incomplete information pertains to quantification of potential impacts that may occur in the unlikely event of a large oil spill. It is well understood that the environmental impacts associated with a large oil spill could be severe, to birds as well as many other environmental resources. These impacts are explained in great detail throughout Chapter 4 of the FEIS as well as the SEIS. Potential impacts are nearly identical under each action alternative (i.e. Alternatives 1, 3 and 4.) The probability of such an event occurring is also identical under each action alternative. It is also well understood that no large oil spills or spill-related impacts could result from a selection of the No Action Alternative. In light of these considerations, the decision-maker already has sufficient information regarding the relative probability and various impacts of a major oil spill to allow a reasoned choice among alternatives, with or without this particular piece of incomplete information. Although the missing information regards a very important issue, it is not essential for a reasoned choice among lease sale alternatives.

Page Number: IV-140

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

While site-specific data on the seasonal distribution of immature and non-breeding yellow-billed loons would be useful in assessing impacts, this information is not essential to a reasoned choice among alternatives in this case and at this stage of the decision-making process. Much information is already known on the general distribution of the yellow-billed loon in the Chukchi Sea. This level of available information is sufficient to support sound scientific judgments and reasoned managerial decisions, even in the absence of additional data of this type. The protections that these birds receive under the MBTA (and now as a Candidate species under the ESA) will serve to preclude or reduce impacts. Also, one should remember the 4-stage OCSLA process at work here. The current decision to be made is at step 2 of the process, the lease sale stage, which is relatively programmatic in nature. Certain site- and project-specific details can only be known at later steps in this process. Any appropriate additional mitigation measures can and will be developed at those later stages, when important information about project locations and details can be known.

Page Number: IV-140

Actual Statement:

Collisions are not documented for shearwaters, but these types of events typically are poorly documented.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The absence of data indicating shearwater mortality from striking vessels/structures does not qualify as missing information and is not relevant to reasonably foreseeable adverse effects on the human environment.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-142

Actual Statement:

The number of birds that could be affected at sea during spring or fall migration is unknown.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS does not anticipate any potential for significant adverse effects on common eiders, even in the event of a large oil spill. Thus, the statement does not indicate any missing information relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-142

Actual Statement:

The portion of Chukchi Sea kittiwakes in the proposed lease-sale area is unknown. Seasonal areas of concentration, if any, are unknown.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

While more detailed understanding of seasonal concentrations (i.e. knowing the exact portion of the Chukchi Sea population in the proposed lease-sale area) of kittiwakes would be helpful, this information is not essential to a reasoned choice among alternatives in this case and at this stage of the decision-making process. Much information is already known on the general habits of kittiwakes in the Chukchi Sea. This level of available information is sufficient to support sound scientific judgments and reasoned managerial decisions, even in the absence of additional data of this type. The protections that these birds receive under the MBTA will serve to preclude or reduce impacts. Also, one should remember the 4-stage OCSLA process at work here. The current decision to be made is at step 2 of the process, the lease sale stage, which is relatively programmatic in nature. Certain site- and project-specific details can only be known at later steps in this process. Any appropriate additional mitigation measures can and will be developed at those later stages, when important information about project locations and details can be known.

Page Number: IV-142

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS did not identify any reasonably foreseeable significant adverse effects to king eiders, even in the unlikely event of a large oil spill. The specific types of information regarding king eiders referenced in the item here are thus not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-143

Actual Statement:

Current population estimates at these colonies are unknown.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

While a more current population estimate for colonies at Cape Thompson and Cape Lisburne would be useful, this information is not essential to a reasoned choice among alternatives in this case and at this stage of the decision-making process. Much information is already known on the general habits of seabirds in the Chukchi Sea. This level of available information is sufficient to support sound scientific judgments and reasoned managerial decisions, even in the absence of additional data of this type. The protections that these birds receive under the MBTA will serve to preclude or reduce impacts. Also, one should remember the 4-stage OCSLA process at work here. The current decision to be made is at step 2 of the process, the lease sale stage, which is relatively programmatic in nature. Certain site- and project-specific details can only be known at later steps in this process. Appropriate additional mitigation measures will be developed at those later stages, when important information about project locations and details can be known.

Page Number: IV-143

Actual Statement:

Reliable estimates of the number of phalaropes using these two locations are unavailable;

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

As this statement indicates, there will be some level of incomplete information on current numbers of phalaropes at various locations. However, there still exists sufficient information to support sound scientific judgments and reasoned managerial decisions regarding potential impacts to phalaropes under each Chukchi Sea lease sale alternative. Precise and up-to-the-minute population counts are not essential to a reasoned choice among alternatives at this relatively programmatic stage. It should also be remembered that subsequent environmental reviews under later OCSLA review stages will be able to consider more current information regarding specific project locations, and thus provide a more robust review than is possible at the lease sale stage.

Page Number: IV-144

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS analysis identified no significant adverse effects to bar-tailed godwits, even during the unlikely event of a large oil spill. Additional information on the numbers, timing, and patterns of use of Kasegaluk Lagoon and Peard Bay by these birds would not be relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-145

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

While additional recent and site-specific data on habitat-use patterns, routes and timing would certainly be useful in assessing impacts, this information is not essential to a reasoned choice among alternatives in this case and at this stage of the decision-making process. Much information is already known on the general habits of the many species of birds that use the Chukchi Sea. This level of available information is sufficient to support sound scientific judgments and reasoned managerial decisions, even in the absence of additional data of this type. The protections that these birds receive under the MBTA will serve to preclude or reduce impacts. Also, one should remember the 4-stage OCSLA process at work here. The current decision to be made is at step 2 of the process, the lease sale stage, which is largely programmatic in nature. Certain site- and project-specific details can only be known at later steps in this process. Any appropriate additional mitigation measures can and will be developed at those later stages, when important information about project locations and details can be known.

Page Number: IV-145

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

While additional recent and site-specific data on habitat-use patterns, routes and timing would certainly be useful in assessing impacts, this information is not essential to a reasoned choice among alternatives in this case and at this stage of the decision-making process. Much information is already known on the general habits of the many species of birds that use the Chukchi Sea. This level of available information is sufficient to support sound scientific judgments and reasoned managerial decisions, even in the absence of additional data of this type. The protections that these birds receive under the MBTA will serve to preclude or reduce impacts. Also, one should remember the 4-stage OCSLA process at work here. The current decision to be made is at step 2 of the process, the lease sale stage, which is largely programmatic in nature. Certain site- and project-specific details can only be known at later steps in this process. Any appropriate additional mitigation measures can and will be developed at those later stages, when important information about project locations and details can be known.

Page Number: IV-145

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

As this general statement indicates, there will be some level of incomplete information on marine mammal ecology in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions at the lease sale stage. Activities with the potential to affect marine mammals will be subject to additional BOEMRE as well as NMFS and/or FWS review processes. Appropriate mitigation measures can and will be applied as proposals for specific activities are submitted. This multi-stage process permits more detailed review of each proposal, and development of more tailored mitigation measures. As per the MMPA and ESA, significant impacts must be avoided. This separate, thorough review and minimized potential for significant impacts is common to all alternatives. In light of the above, any "incomplete information" regarding marine mammal ecology and specific locations of future developments is not essential to a reasoned choice between alternatives at the lease sale stage.

Page Number: IV-145

Actual Statement:

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 non-endangered and non-threatened 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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

Sufficient information about marine mammals response to development and noise is available to support sound scientific judgments and reasoned managerial decisions at the lease sale stage. Activities with the potential to affect marine mammals, such as drilling and seismic operations, will be subject to additional BOEMRE as well as NMFS and/or FWS review processes. Appropriate mitigation measures can and will be applied as proposals for specific activities are submitted. This multi-stage process permits more detailed review of each proposal, and development of more tailored mitigation measures. As per the MMPA and ESA, significant impacts must be avoided. This separate, thorough review and minimized potential for significant impacts is common to all alternatives. In light of the above, any "incomplete information" regarding potential noise impacts from future projects is not essential to a reasoned choice between alternatives at the lease sale stage.

Page Number: IV-147

Actual Statement:

It is uncertain how seismic surveys potentially might impact seal-food resources in the immediate vicinity of the survey.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The thorough FEIS analysis of potential effects of seismic surveys did not identify impacts to seal food resources in the immediate vicinity of a survey to be a notable concern. This item is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-147

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have an unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-148

Actual Statement:

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 walruses to seismic operations.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects. (It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.)

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-148

Actual Statement:

Quantitative research on the sensitivity of walruses to noise has been limited because no audiograms (a test to determine the range of frequencies and minimum hearing threshold) have been done on walruses.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have an unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorization generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects. (It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.)

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-148

Actual Statement:

Although the hearing sensitivity of walruses is poorly known, source levels are thought to be high enough to cause temporary hearing loss in other species of pinnipeds.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have an unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorization generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects. (It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.)

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-150

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities (including the seismic activities and related vessel and air traffic) under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from certain activities, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-151

Actual Statement:

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).

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

This statement does not indicate missing information relevant to reasonably foreseeable adverse effects on the human environment.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-151

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects. It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-152

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have an unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorization generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects. (It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.)

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-154

Actual Statement:

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).

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have an unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorization generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, additional information on the biological relevance of cetacean's immediate behavioral responses to human activities is not relevant to any reasonable foreseeable significant adverse effects. It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-154

Actual Statement:

[M]onitoring 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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have an unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, the ability to infer biological significance of short-term behavioral observations is not relevant to any reasonable foreseeable significant adverse effects. It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-156

Actual Statement:

[W]ithout historical data on distribution and abundance, it is not possible to measure the impacts of an oil spill on marine mammals.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. The analysis already assumes that a large oil spill would lead to significant impacts. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-157

Actual Statement:

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).

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that a large oil spill would lead to significant impacts. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration and extent of impacts (including potential impacts on high-latitude mollusks), while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-158

Actual Statement:

[T]he 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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that a large oil spill would lead to significant impacts. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-159

Actual Statement:

The potential effect of crude oil on the function of the cetacean blowhole is unknown.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that a large oil spill would lead to significant impacts. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-159

Actual Statement:

Although there is very little definitive evidence linking cetacean death or serious injury to oil exposure,

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The lack of evidence of an effect does not constitute missing information relevant to a reasonably foreseeable significant adverse effect.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-160

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that a large oil spill would lead to significant impacts. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-160

Actual Statement:

The effects of oil contacting skin largely are speculative.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that if oil contacted cetacean skin, significant impacts would occur. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-161

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

This piece of incomplete information pertains to potential impacts that may occur in the unlikely event of a large oil spill. It is well understood that the environmental impacts associated with a large oil spill could be severe, in terms of beluga prey species and to beluga themselves. These impacts are explained in great detail throughout Chapter 4 of the FEIS as well as the SEIS. Potential impacts are nearly identical under each action alternative (i.e. Alternatives 1, 3 and 4.) The probability of such an event occurring is also identical under each action alternative. It is also well understood that no large oil spills or spill-related impacts could result from a selection of the No Action Alternative. In light of these considerations, the decision-maker already has sufficient information regarding the relative probability and various impacts of a major oil spill to allow a reasoned choice among alternatives, with or without this particular piece of incomplete information. Although the missing information regards a very important issue, it is not essential for a reasoned choice among lease sale alternatives.

Page Number: IV-161

Actual Statement:

The effects of a large oil spill and subsequent exposure of whales to fresh crude oil are uncertain, speculative, and controversial.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that a large oil spill would lead to significant impacts. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-161

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that a large oil spill would lead to significant impacts. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-161

Actual Statement:

There is great uncertainty about the effects of fresh crude oil on cetacean calves.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that if cetacean calves were exposed to fresh crude, significant impacts would occur. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-161

Actual Statement:

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).

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The analysis already assumes that a large oil spill would lead to significant impacts to cetaceans if they or their habitats are exposed. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives. This is especially true where the uncertainty alluded to pertains specifically to the results of past studies of other areas.

Page Number: IV-162

Actual Statement:

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).

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

This item simply makes a recommendation based on the premise that there is certain incomplete information, and does not indicate any connection between allegedly missing information and any significant adverse impacts.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-162

Actual Statement:

In conclusion, there is uncertainty about effects on cetaceans in the event of a large spill.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The analysis already assumes that a large oil spill would lead to significant impacts to cetaceans if they or their habitats are exposed. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-163

Actual Statement:

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).

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

While additional information on the distribution and timing of movements of belugas would be useful, this information is not essential to a reasoned choice among alternatives in this case. Much information is already known on the general habits of the belugas that use the Chukchi Sea. This level of available information is sufficient to support sound scientific judgments and reasoned managerial decisions regarding formulation and selection of lease sale alternatives. The protections that this species receives under the MMPA will also serve to preclude or reduce impacts under all action alternatives.

Page Number: IV-165

Actual Statement:

With the limited background information available regarding large oil spills in the offshore arctic environment, the outcome of a large oil spill is uncertain.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

This piece of incomplete information pertains to potential impacts that may occur in the unlikely event of a large oil spill. It is well understood that the environmental impacts associated with a major oil spill could be severe, to polar bears as well as many other environmental resources. These impacts are explained in great detail throughout Chapter 4 of the FEIS as well as the SEIS. Potential impacts are nearly identical under each action alternative (i.e. Alternatives 1, 3 and 4.) The probability of such an event occurring is also identical under each action alternative. It is also well understood that no large oil spills or spill-related impacts could result from a selection of the No Action Alternative. In light of these considerations, the decision-maker already has sufficient information regarding the relative probability and various impacts of a major oil spill to allow a reasoned choice among alternatives, with or without this particular piece of incomplete information. Although the missing information regards a very important issue, it is not essential for a reasoned choice among lease sale alternatives.

Page Number: IV-166

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on the CBS stock denning areas compared to the SBS stock. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions. Additional information on this topic is not essential to a reasoned choice among alternatives. Moreover, additional processes (e.g. ESA Section 7) will help ensure lack of significant impacts under each alternative if/when projects are sited.

Page Number: IV-168

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on the exact amount of illegal harvest of polar bears in Russia; however, the important information is that specialists have agreed to a population size and trend for management purposes. Such information was used to support sound scientific judgments and reasoned managerial decisions. Additional information on this point is not essential for a reasoned choice among alternatives at the lease sale stage. Furthermore, the missing information pertains to impacts that are common to all alternatives, a fact which tends to reduce the utility of such information to the decision-maker.

Page Number: IV-194

Actual Statement:

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

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill, a separate issues from the construction discussed in the item here. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-194

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have an unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill, a separate issues from the construction discussed in the item here. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-216

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that a large oil spill would lead to significant impacts. The severity of such impacts would not vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-217

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to a small subset of adverse effects that is already assumed to occur under certain circumstances. The analysis already assumes that a large oil spill would lead to significant impacts. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-217

Actual Statement:

There is uncertainty about effects on bowheads (or any large cetacean) in the event of a large spill.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The analysis already assumes that a large oil spill would lead to significant impacts to cetaceans if they or their habitats are exposed. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: IV-217

Actual Statement:

For beluga whales, there also is uncertainty about effects on them in the event of a very large spill.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on the level of effects on marine mammals from oil contact. This information is important; however, it pertains to a small subset of potential adverse effects that is already assumed to occur under particular circumstances, i.e., those that may occur in the unlikely event of a large oil spill. For reasons discussed in many other responses, the decision-maker already has sufficient information regarding the relative probability and various impacts of an oil spill to allow a reasoned choice among alternatives.

Page Number: IV-218

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There will be some level of incomplete information on the effects of oil on rare fish species in the Arctic. This information is important; however, it pertains to a small subset of potential adverse effects that is already assumed to occur under particular circumstances, i.e., those that may occur in the unlikely event of a large oil spill. For reasons discussed in many of these responses, the decision-maker already has sufficient information regarding the relative probability and various impacts of an oil spill to allow a reasoned choice among alternatives.

Page Number: IV-256

Actual Statement:

The disparate mortality rates are less well understood.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

There is no connection between disparate mortality (i.e. cancer) rates among local people and any reasonably foreseeable significant adverse effects from the Proposed Action.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-258

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The possible contribution of these environmental factors has no connection to the Proposed Action and has no relevance to any reasonably foreseeable significant adverse effects identified in the FEIS.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-265

Actual Statement:

However, there are significant gaps in the data for the period 1979-1989.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

There is no discernible connection between this incomplete information and any reasonably foreseeable significant adverse effects identified in the FEIS.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: IV-269

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

As this general statement indicates, there will be some level of incomplete information on marine mammal distribution and habitat use in offshore areas of the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions at the lease sale stage. Activities with the potential to affect marine mammals will be subject to additional BOEMRE as well as NMFS and/or FWS review processes. Appropriate mitigation measures can and will be applied as proposals for specific activities are submitted. This multi-stage process permits more detailed review of each proposal, and development of more tailored mitigation measures. As per the MMPA and ESA, significant impacts must be avoided; these laws apply under all alternatives. In light of the above, any "incomplete information" regarding marine mammal distribution and habitat use is not essential to a reasoned choice between alternatives at the lease sale stage.

Page Number: V-16

Actual Statement:

It is not known to what extent local sources in Alaska contribute to arctic haze in the State.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

There is no connection between the extent to which local sources in Alaska contribute to Arctic haze and any reasonably foreseeable significant adverse effects identified in the FEIS.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-16

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Based on the calculations for the emissions for other greenhouse gases, no significant adverse effects from emissions of nitrous oxide are anticipated. Thus, any missing information is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-19

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The lack of an indication that any human activity has had a significant adverse impact on the current status of the BCB Seas bowhead or their recovery does not qualify as missing information relevant to reasonably foreseeable adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-20

Actual Statement:

Whether there are long-lasting behavioral effects from this activity are unknown, but overall habitat use appears to be relatively unaffected.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS did not identify any significant adverse effects to whales from subsistence whale hunting. The missing information is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-20

Actual Statement:

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 behavior from such activities in either evaluation area.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS did not identify any significant adverse effects to bowheads from past offshore oil and gas related seismic surveys or ice-management activities. The missing information is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-20

Actual Statement:

[D]ata on other potential perturbations (e.g., past seismic surveys and oil spills) are not sufficient to clearly know the level of effects.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS did not identify any significant adverse effects to bowheads from past seismic surveys or oil spills. The missing information is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-20

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities (including those producing relatively high levels of anthropogenic noise) under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from certain activities, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, any "incomplete information" on variability in bowhead responsiveness to anthropogenic noise is not relevant to any reasonable foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-20

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

As the conclusion to this statement indicates, there is sufficient information available to support sound scientific judgments and reasoned managerial decisions regarding the effect of these perturbations on bowheads. Additional information on these issues is not essential to a reasoned choice among alternatives.

Page Number: V-20

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The lack of information indicating the existence of additional human-related causes of mortality does not qualify as missing information relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-21

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

There is no connection between the missing information and any reasonably foreseeable significant adverse effects associated with the Proposed Action or alternatives. The FEIS does not anticipate any significant adverse effects to marine mammals outside the unlikely event of a large oil spill. Additionally, subsistence hunting would occur to the same extent under all alternatives, a fact which further reduces the utility of such information to the decision-make here.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-21

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

There is some level of uncertainty regarding the speculative potential for short-term impacts to whales following hunts. However, sufficient information regarding whales behavior, avoidance patterns, etc are available to support sound scientific judgments and reasoned managerial decisions. It should also be noted that these possibilities have already been taken into account in the development of various alternatives and deferral areas. Enough is already known about this potential for impacts such that reasoned choices among alternatives can be made. Additional information is not essential.

Page Number: V-22

Actual Statement:

There are insufficient data to make reliable predictions of the effects of Arctic climate change on bowhead whales.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

There is no connection between this missing information and any reasonably foreseeable significant adverse effects to bowheads identified in the FEIS.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-22

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The lack of data on potential impacts to bowheads from commercial fishing is not relevant to any reasonably foreseeable significant adverse effects identified in the FEIS.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-23

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

This assertion, which appears in one particular study, does not qualify as missing information relevant to reasonably foreseeable significant adverse effects. Vessel noise is not anticipated to cause any significant adverse effects to bowheads.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-25

Actual Statement:

[R]ecent 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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The absence of data indicating long-lasting avoidance following seismic survey does not qualify as missing information relevant to reasonably foreseeable significance adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-25

Actual Statement:

Available data . . . are inadequate to fully address issues about effects of past oil and gas activity specifically in the Chukchi Sea on bowhead behavior.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS did not identify any significant adverse effects to bowheads from past oil and gas activities in the Chukchi Sea. The missing information is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-25

Actual Statement:

[W]e 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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

There is no connection between this missing information and any reasonably foreseeable significant adverse effects identified in the FEIS.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-25

Actual Statement:

However there are significant gaps in the data for the period 1979-1989 and very limited information was obtained on ice management (Wainwright, 2002).

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

There is no discernible connection between ice management data from 1979-1989 and any reasonably foreseeable significant adverse effects identified in the FEIS.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-26

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Activities under each action alternative would be required to comply with the Marine Mammal Protection Act, including its prohibition on "take." NMFS may grant authorizations for incidental take for activities having no more than a negligible effect on the species (or stock) in question, and that would not have unmitigable adverse impacts on the availability of the marine mammals for subsistence uses. Also, permissible methods of taking and requirements pertaining to monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. The MMPA regulatory thresholds for take of marine mammals via noise err on the side of caution, and are designed to encompass a variety of potential direct and indirect effects. Take authorizations generally incorporate project- or activity-specific mitigation measures to avoid or further reduce potential impacts. Despite the indication of uncertainty regarding the potential level of effect from anthropogenic noise, BOEMRE remains confident that the existing regulatory framework is sufficient to prevent noise impacts from having more than a negligible level of effect. A negligible level of effect as defined by the MMPA could not rise to "significance" as defined in Section IV.A.1. of the FEIS. The FEIS itself anticipates that significant adverse effects to marine mammals could only occur as a result of the unlikely event of a large oil spill. In light of these considerations, this item of "incomplete information" is not relevant to any reasonable foreseeable significant adverse effects. (It should also be noted that several marine mammal species receive additional protections against significant adverse effects from the Endangered Species Act.)

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-27

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

There is no connection between the missing information and any reasonably foreseeable significant adverse effects identified in the FEIS.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-27

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

The missing information pertains to adverse effects that are already assumed to occur under certain circumstances. The analysis already assumes that if a large oil spill occurs, significant impacts to cetaceans could follow. Neither the probability nor severity of such impacts would vary amongst any of the action alternatives. The decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives. Additional information on the myriad potential mechanisms of effects, specific behavioral responses, or exact duration of impacts, while potentially useful, is not essential to a reasoned choice among alternatives.

Page Number: V-28

Actual Statement:

The possible influences of disease or predation and of overutilization are listed as 'Unknown.'

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Lack of information on the possible threat of disease or predation or overutilization of fin whales does not constitute missing information relevant to reasonably foreseeable significant adverse effects. There is no connection between the proposed action and these issues.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-29

Actual Statement:

The threat of disease or predation is unknown.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Lack of information on the possible threat of disease or predation on humpback whales does not constitute missing information relevant to reasonably foreseeable significant adverse effects. There is no correlation between the proposed action and these issues.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-29

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The lack of records indicating that humpbacks were killed or injured by commercial fishing operations does not constitute missing information relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-30

Actual Statement:

The impacts of pollution and habitat degradation due to coastal development are not known.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS does not anticipate any adverse effects on humpback whales from pollution or habitat degradation associated with coastal development. The statement does not indicate any missing information relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-31

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Lack of published information on contamination impacts on the Pacific walrus does not constitute missing information relevant to reasonably foreseeable significant adverse effects. No such effects of this type to Pacific walrus were identified in the FEIS.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-32

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

As this general statement indicates, there will be some level of incomplete information on marine mammal distribution, population size and habitat use in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions at the lease sale stage. Activities with the potential to affect marine mammals will be subject to additional BOEMRE as well as NMFS and/or FWS review processes. Appropriate mitigation measures can and will be applied as proposals for specific activities are submitted. This multi-stage process permits more detailed review of each proposal, and development of more tailored mitigation measures. As per the MMPA and ESA, significant impacts must be avoided. This separate, thorough review and minimized potential for significant impacts is common to all alternatives. In light of the above, any incomplete information regarding marine mammal distribution, population size and habitat use is not essential to a reasoned choice between alternatives at the lease sale stage.

Page Number: V-32

Actual Statement:

Unfortunately, there is no information to determine whether or not there are health effects for walruses at this cadmium level.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Lack of information demonstrating adverse health effects does not qualify as missing information relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-35

Actual Statement:

[T]he relationship between the expanding gray whale population to amphipod community dynamics is unknown but is of considerable interest.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

While this statement indicates that this information may be of some interest to certain scientists, it does not indicate any missing information relevant to reasonably foreseeable adverse effects on the human environment.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-36

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The exact size of illegal harvest of polar bears in Russia is not related to any component of the Proposed Action or relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-36

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Sufficient data existed to determine that no significant adverse effects to polar bears would occur as a result of the Proposed Action, absent a large oil spill, a consideration distinct from the disturbance impacts discussed in this item. Additional quantitative data specifically addressing the cumulative impacts of development on polar bears is therefore not relevant to reasonably foreseeable significant adverse effects. Uncertainty regarding the spatial scope of potential industry activities on the Alaskan OCS is inherent to the lease sale stage; this statement does not identify any missing information that is relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-36

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The exact size of the illegal polar bear harvest in Russia is not relevant to reasonably foreseeable significant adverse effects of the Proposed Action or alternatives.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-46

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The FEIS did not identify any significant adverse effects to subsistence activities from these activities or trends. The missing information is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-48

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

This piece of incomplete information pertains to quantification of potential impacts that may occur in the unlikely event of a large oil spill. It is well understood that the environmental impacts associated with a large oil spill could be severe, to baleen whales as well as many other environmental resources. These impacts are explained in great detail throughout Chapter 4 of the FEIS as well as the SEIS. Potential impacts are nearly identical under each action alternative (i.e. Alternatives 1, 3 and 4). The probability of such an event occurring is also identical under each action alternative. It is also well understood that no major oil spills or spill-related impacts could result from a selection of the No Action Alternative. In light of these considerations, the decision-maker already has sufficient information regarding the relative probability and various impacts of a large oil spill to allow a reasoned choice among alternatives, with or without this particular piece of incomplete information. Although the missing information regards a very important issue, it is not essential for a reasoned choice among lease sale alternatives.

Page Number: V-49

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

The missing data identified are associated with the ability to evaluate effects on bowhead whales from activities in the mid-1970s. These effects are not connected to the proposed action and are not relevant to reasonably foreseeable significant adverse effects identified by the FEIS.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-52

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

Sufficient data existed to determine that no significant adverse effects to polar bears would occur as a result of the Proposed Action, absent a large oil spill, a consideration distinct from the "disturbance" impacts discussed in this item. Additional quantitative data specifically addressing the cumulative impacts of development on polar bears is therefore not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-59

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? NO

If NO, explain:

As the FEIS (page V-16) explains, the proposed action has no appreciable influence on climate change. This information is not relevant to reasonably foreseeable significant adverse effects.

Is the Statement Essential to Making a Reasoned Choice?

If NO, explain:

Page Number: V-68

Actual Statement:

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.

Is the Statement Relevant to Potentially Significant Effects? YES

If NO, explain:

Is the Statement Essential to Making a Reasoned Choice? NO

If NO, explain:

Although additional baseline data regarding sociocultural systems could prove useful in understanding the nuances of potential significant effects, existing information regarding the social organization, cultural values, and institutional arrangements of Chukchi Sea communities is more than adequate to support informed effects analysis and reasoned managerial decisions. Moreover, the analysis indicates that significant impacts to sociocultural system could occur only under limited circumstances (large oil spills or large scale oil exploration, development, and production activities within close proximity to a coastal community). The nature, severity, and likelihood of such significant effects do not vary appreciably as between action alternatives. In sum, additional baseline data regarding sociocultural systems is not essential to a reasoned choice among lease sale alternatives.

Very Large Oil Spill

Information, Models, Estimates

Supporting Tables and Figures

Table of Contents

List of Tables

List of Figures

Appendix B. Oil-Spill Information, Models, and Estimates

The Sale 193 Chukchi Sea FEIS details the results of the oil spill analysis in Appendix A of that document (USDOI, MMS, 2007), and is incorporated by reference. That information includes (1) estimates of the source, type, and size of oil spills, (2) behavior and fate of crude oils, (3) modeling simulations of oil weathering, (4) estimates of where an offshore oil spill may go, (5) oil-spill-risk-analysis, and (6) small oil spills. The updates in this Sale 193 SEIS Appendix B include information on topics 1 through 5 above that is relevant to the VLOS (very large oil spill) analysis.

1. Estimates of Source and Size

Very large spills could potentially come from four sources associated with OCS exploration or development operations: (1) pipelines (2) facilities (3) tankers or (4) support vessels. BOEMRE reviewed those four sources and determined well-control incidents have the potential for the largest spill volumes, assuming all primary and secondary safeguards fail and the well does not bridge. At this time, pipelines are the preferred mode of petroleum transport (over tankers) in the Chukchi OCS and, therefore, BOEMRE did not consider the loss of a fully loaded tanker. The loss of the entire volume in an offshore pipeline would be less than a long duration well control incident with high flow rates. Support vessels were considered based on foundering and the loss of entire fuel tanks, and determined to be less volume than a well control incident where all primary and secondary safeguards failed. For purposes of analysis, BOEMRE examined a well control incident which escalates into a catastrophic blowout.

1.1. OCS Well Control Incidents

This section updates information in the Sale 193 FEIS Appendix A, Section A.1.c which discussed OCS well control incidents from 1971-2005. The year 1971 is considered reflective of the modern regulatory environment. The term “loss of well control” was first defined in a 2006 update to the incident reporting regulations (30 CFR 250.188). Prior to this 2006 update, the incident reporting regulations included the requirement to report all blowouts, and the term blowout was undefined. Three relevant data sets are considered: (1) all well control incidents from 1971-2009 prior to the *Deepwater Horizon* (DWH) event to update the Sale 193 FEIS information baseline, (2) well control incident rates from exploration and development drilling including the DWH event, and (3) spills associated with well control incidents from exploration drilling including the DWH event (USDOI, BOEMRE, AIB, 2011).

Exploratory and Development/Production Operations from 1971-2009. There were 249 well control incidents during exploratory and development/production operations on the OCS (this includes incidents associated with exploratory and development drilling, completion, workover, plug and abandon, and production operations). During this period, 41,514 wells were drilled on the OCS and 15.978 billion barrels (Bbbl) of oil were produced. Of the 249 well control incidents that occurred during this period, 50 (20%) resulted in the spillage of condensate/crude oil ranging from <1 bbl (barrel) to 450 bbls (barrels). The total spilled from these 50 incidents was 1,829 bbls. This volume was approximately 0.00001147% of the volume produced during this period.

In 2010, four well control incidents occurred, including the DWH event. Although a final spillage volume from the DWH event has not been determined by BOEMRE, the current estimate from Lubchenco et al. (2010) is 4.9 million bbls. The three other well control incidents that occurred in 2010 did not result in the spillage of condensate/crude oil.

Development and Exploration Well Drilling from 1971-2010. There were a total of 41,781 wells drilled in the OCS comprising of 40,565 wells in the Gulf of Mexico, 1,086 wells in the Pacific

Region, 46 wells in the Atlantic Region and 84 wells in the Alaska Region. Of these, 26,245 were development wells, 15,491 were exploration wells and 43 were core tests or relief wells. The overall drilling well control incident rate is one well control incident per 292 wells drilled, compared to one well control incident per 410 development wells drilled, and 1 well control incident per 201exploration wells drilled. These well control incident rates include all well control incidents related to drilling operations whether or not a spill occurred.

Exploration Well Drilling from 1971-2010. Industry has drilled 223 exploration wells in the Pacific OCS, 46 in the Atlantic OCS, 15,138 in the Gulf of Mexico OCS, and 84 in the Alaska OCS, for a total of 15,491 exploration wells. During this period, there were 77 well control incidents associated with exploration drilling. Of those 77 well control incidents, 14 (18%) resulted in oil spills ranging from 0.5 bbl to 200 bbls, for a total 354 bbls, excluding the estimated volume from the DWH event. From 1971-2010 one well control incident resulted in a spill volume of 1,000 bbls or more and that was the DWH event.

1.2. Historical Worldwide Spills Greater than or Equal to 1 Million Barrels from Wells

Very large spills occur very infrequently, and there are limited data for use in statistical analysis and predictive efforts. The chance of a very large spill occurring is very low. Five of the well control-incident events ≥1,000 bbl in the OCS database occurred between 1964 and 1970 (Table B-1). Following the Santa Barbara well control incident in 1969 and two large spills from well control

Table B-1. Number of well control incidents with pollution per year in the Gulf of Mexico and Pacific OCS Regions, and total OCS wells.

Year	Total Number of Incidents	Incidents with Condensate/ Crude Oil	Condensate/Crude Oil Spilled (bbls)			Product -ion	Drilling				Workover/ Completion	Well Type	Well Type	Wells Drilled
			Production, Workover, Completion, P&A	Drilling	Total Exploration and Development	Total	Total	Exploration	Development	Unknown	Total	Development	Exploration	Total
1956	1	0	—	—	0	—	1	—	1	0	—	204	46	258
1957	1	0	—	—	0	—	1	—	1	0	—	333	58	391
1958	2	1	0.9	—	0.9	—	1	1	—	0	1	210	65	275
1959	1	0	—	—	0	—	1	—	1	0	—	229	96	325
1960	2	0	—	—	0	1	1	1	—	0	—	290	138	428
1961	0	0	—	—	0	—	—	—	—	0	—	351	133	484
1962	1	0	—	—	0	—	1	—	1	0	—	385	159	544
1963	1	0	—	—	0	—	1	1	—	0	—	400	209	609
1964	7	3	10,280	100	10,380	4	3	2	1	0	—	507	234	742
1965	5	2	0.9	1688	1,688.9	1	4	1	3	0	—	648	194	842
1966	2	2	0.9	0.9	1.8	—	1	—	1	0	1	628	299	973
1967	2	1	0.9	—	0.9	0	—	—	—	—	2	638	321	988
1968	8	0	—	—	0	1	6	2	4	—	1	735	358	1094
1969	3	3	—	82,500.9	82,500.9	0	3	1	2	0	—	731	254	993
1970	3	2	118,000.0	—	118,000.0	1	1	—	1	0	1	756	248	1006
1956-1970	39	14	128,283.60	84,289.80	212,573.40	8	25	9	16	0	6	7,045	2,812	9,952
Major Regulatory Changes to Outer Continental Shelf Lands Act														
1971	6	2	460	—	460	2	2	1	1	0	2	620	285	909
1972	6	2	2	0.9	2.9	1	4	2	2	—	1	608	309	917
1973	3	1		0.9	0.9	0	3	2	1	—	—	569	321	890
1974	6	2	275	—	275	2	2	1	1	—	2	512	355	869
1975	7	1	0.9	—	0.9	—	5	4	1	—	2	569	334	904
1976	6	0	—	—	0	1	5	1	4	—	—	851	317	1169
1977	10	1	2	—	2	1	4	3	1	—	5	975	398	1373

Year	Total Number of Incidents	Incidents with Condensate/ Crude Oil	Condensate/Crude Oil Spilled (bbls)			Product -ion	Drilling				Workover/ Completion	Well Type	Well Type	Wells Drilled
			Production, Workover, Completion, P&A	Drilling	Total Exploration and Development	Total	Total	Exploration	Development	Unknown	Total	Development	Exploration	Total
1978	12	1	0.9	—	0.9	—	8	4	4	—	4	935	361	1298
1979	5	2		1.8	1.8	—	5	4	1	—	—	895	420	1316
1980	8	1	1	—	1	2	4	3	1	—	2	943	412	1356
1981	10	5	66.7	0.9	67.6	1	3	1	2	—	6	1012	400	1412
1982	9	2	1.8	—	1.8	—	5	1	4	—	4	970	457	1427
1983	12	1	—	2	2	—	10	5	5	—	2	872	458	1330
1984	5	0	—	—	0	—	4	3	1	—	1	862	663	1525
1985	6	1	50	—	50	0	4	3	1	—	2	783	574	1361
1986	2	0	—	—	0	—	1	—	1	—	1	517	296	813
1987	8	2	61	—	61	3	2	2	—	—	3	534	439	973
1988	4	1	4.5	—	4.5	1	2	1	1	—	1	510	584	1094
1989	12	0	—	—	0	3	7	4	3	0	2	572	489	1061
1990	7	3	17.5	—	17.5	0	3	1	1	1	4	638	521	1159
1991	8	1	—	0.8	0.8	—	6	3	3	0	2	483	350	833
1992	3	1	—	100	100	—	3	3	—	—	—	376	229	605
1993	4	0	—	—	0	—	4	1	3	—	—	645	365	1010
1994	1	0	—	—	0	—	—	—	—	—	1	686	438	1124
1995	1	0	—	—	0	—	1	0	1	—	—	784	395	1179
1996	4	0	—	—	0	—	2	1	1	—	2	805	462	1267
1997	5	0	—	—	0	—	4	1	3	—	1	932	549	1481
1998	9	3	2.6	1.62	4.22	3	3	2	1	—	3	665	495	1161
1999	5	1	125	—	125	—	3	1	2	—	2	676	371	1048
2000	9	3	0.02	200.5	200.52	—	8	6	2	—	1	950	443	1396
2001	10	1	1	—	1	2	5	2	3	—	3	867	411	1278
2002	6	3	350.505	—	350.505	2	3	1	2		1	654	310	964
2003	5	1	10	—	10	2	2	0	1	1	1	557	354	911
2004	6	4	2.5	22.06	24.56	1	3	3	—	—	2	569	363	932
2005	4	0	—	—	0	—	4	1	3	—	—	482	355	841
2006	2	2	10	24.5	34.5	—	1	1	—	—	1	375	414	789
2007	8	—	—	—	—	2	2	2			4	328	300	630
2008	9	0	—	—	0	3	4	1	3		2	304	267	571
2009	6	2	27.94	—	27.94	1	1	1			4	179	147	338
2010	4	1	—	TBD	TBD	3	1	1			0	181	80	267
1971-2010*	**253**	**51**	**1,472.87**	**355.98**	**1,828.85**	**36**	**143**	**77**	**64**	**2**	**74**	**26,245**	**15,491**	**41,781**

Notes: Wells drilled columns include hydrocarbon, sulfur and salt wells. The total column includes core tests and relief wells in addition to exploration and development wells; therefore the total column may be slightly higher than the sum of the development and exploration wells columns for some years.
TBD - the final volume for the *Deepwater Horizon* that occurred on 4/20/2010 has not been determined by BOEMRE.
* The 1971-2010 spill volume totals for the columns showing Drilling and Total Exploration and Development do not include the volume for the DWH incident that occurred on 4/20/2010.
Source: BOEMRE, Accident Investigation Board (2011)

incidents in the Gulf of Mexico in 1970, amendments to the OCS Lands Act through OCS orders significantly strengthened safety, inspection, and pollution-prevention requirements for OCS offshore activities. Well control training, redundant pollution-prevention equipment, and subsurface safety devices are among the provisions that were adopted in the regulatory program at that time. For 39 years no OCS well control incidents resulted in a large oil spill. The sixth OCS well control incident resulting in a large spill, the DWH event, occurred in 2010 and has also precipitated changes in regulations. Although no official volume has been determined by BOEMRE it is clear from the spill volume estimates that the DWH event exceeds the threshold of a VLOS; the current estimate from Lubchenco et al. (2010) and McNutt et al. (2011) is 4.9 million bbls. and is likely greater than 1 million bbls (Lubchenco et al. 2010, McNutt et al. 2010).

Internationally, from 1979 through 2010, six oil well incidents (resulting in an oil spill of greater than or equal to 1 million bbls) were identified from the peer reviewed or “gray” literature (Table B-2). Two of the well incidents were the result of military action. There were roughly 781 Bbbl of oil produced worldwide from 1979–2009 (British Petroleum, 2010). These data provide an approximate rate of about one incident for every 130 Bbbl of oil produced worldwide. Using international data increases the size of the data set and is more likely to capture rare events. However, it assumes that non-US events are relevant to US events to the extent that technology, maintenance, operational standards and other factors are equal; but this is not likely to be the case (especially in cases of military action). Nonetheless, it does show these types of events are rare.

Table B-2. International Historical Spills from Wells Greater than or Equal to 1 MMbbl.

Name	Location	Begin	End	Duration	Barrels	Source
Lakeview Gusher	United States, Kern County, California	3/14/1910	9/1911	18 months	9,000,000	Anonymous, 2003
Gulf War Oil Spill*	Kuwait		1/23/1991		5,500,000-11,000,000	1,2,3,4, Fingas, 2000
Deepwater Horizon/Macondo	United States, OCS, Gulf of Mexico	4/20/2010	7/15/2010	87 Days	4,900,000	McNutt et al., 2011
Ixtoc	Mexico, Gulf of Mexico		6/3/1979	295 Days	3,500,000	OSIR, 1998; Etkin, 2009; Fingas, 2000
Well No 5. Fergana Valley	Uzbekistan, Fergana Valley, Mingbulak Oil Field	3/2/1992		> 4 weeks	2,095,238	OSIR, 1998; Fingas, 2000
Nowruz Oil Field No. 3 Well*	Iran, Persian Gulf	2/4/1983	9/18/1983	224 days	1,904,762	OSIR, 1998; NOAA, 1983
D-103	Libya, near Al Fuqaha	8/11/1980		5 months	1,000,000	OSIR, 1998; Fingas, 2000

Note: * Military attack-related events
Source: USDOI, BOEMRE, (2011) compiled from cited references.

1.3. Oil Spill Risk Analysis

The information from Bercha (2006) was used in the USDOI MMS (2007) oil-spill analyses in the Chukchi Sea. The BOEMRE revisited the input variables used in the Bercha (2006) fault tree analysis. The intent was to compare the well control incident frequencies used in the fault tree analysis to the general rate estimated from 1971-2010 to determine if it was within the bounds of the original estimated well control incident frequencies.

To model the historical data variability for Arctic exploration well blowouts, Bercha applied a numerical simulation approach to develop the probability distribution for blowouts of 150,000 bbl (23,848 m^3) or greater, and arrived at a frequency ranging from a low of 1.5×10^{-4} per well to a high of 6.97×10^{-4} per well. The expected value for a blowout of this size was computed to be 3.94×10^{-4} per well (Bercha 2006). To address causal factors associated with blowouts, Bercha applied adjustments for improvements to logistics support and drilling contractor qualifications that resulted in lower predicted frequencies for Arctic drilling operations. No fault-tree analysis or unique Arctic effects were applied as a modification to existing spill causes for exploration, development, or production drilling frequency distributions. For exploration wells drilled in analogous water depths to planned Chukchi Sea wells (30-60 m), Bercha (2006) estimated the adjusted frequency to be 6.8×10^{-4} per well for a blowout sized between 10,000 bbl (1,590 m^3) and 149,000 bbl (23,689 m^3) and 3.9×10^{-4} per well for a blowout >150,000 bbl (23,848 m^3).

Based on the well control incident data in Table B-1, the frequency of OCS well control incidents spilling fluids ≥150,000 bbl from 1971-2010 has not exceeded the frequencies used in the fault tree analysis for the Sale 193 oil spill analysis.

2. Behavior and Fate of Crude Oils

The Sale 193 FEIS Appendix A.1, Section B summarizes the behavior and fate of crude oil and is incorporated by reference. This section summarizes and updates relevant information to the VLOS analysis.

2.1 Release from A Well Control Incident

A very large oil and gas release could rise to the ocean surface from the shallow to moderate depths on the seafloor (e.g. 1979 Ixtoc I) or fall to the surface of the ocean. The force of the gas would facilitate small oil droplets (0.5 – 2.0 mm) to form and disperse in the ocean or atmosphere (Dickins and Buist, 1981; Belore, McHale and Chapple, 1998; S.L. Ross Environmental Research Ltd, D.F. Dickins and Associates Ltd., and Vaudrey and Associates Inc., 1998). A small portion (1-3%) of droplets could form a plume as identified from Ixtoc at shallow to moderate depths without the injection of dispersants (Boehm and Fiest, 1982). The more soluble compounds within the oil may dissolve, particularly from small droplets that are prevalent in the vertical plume, where the vigorous turbulence occurs (Adcroft et al. 2010). Figure B-1a shows a subsea blowout in shallow to moderate water depths (Westergaard, 1980). A subsea release in shallow to moderate depths moves through

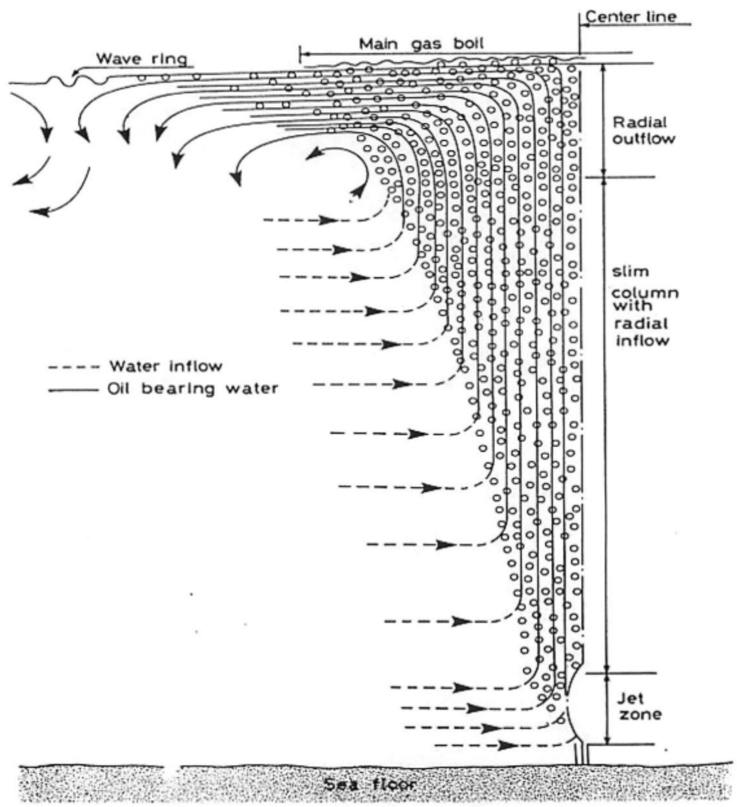


Figure B-1a. Shallow Underwater Blowout Plume. (Source: Westergaard, 1980)

three zones: (1) a jet zone causing turbulence and droplet formation, (2) a buoyancy zone where gas, oil, and water are carried to the surface and droplet size governs rise velocity, and (3) a surface interaction zone where the surface influence carries the oil with the prevailing currents or ice and the gas exits into the atmosphere, which causes a surface boil zone (Westergaard, 1980; PCCI, 1999;

Reed et al., 2006). Volatile organic carbons would be measurable in the atmosphere downwind of the spill in a small area confined to a narrow plume (deGouw et al., 2011; Ryerson et al., 2011) during the summer open water and broken ice seasons.

For well control incidents at shallow to moderate depths, the gas is considered to be an ideal gas with a specific volume decreasing linearly with pressure. Dissolution of gas from rising bubbles may be minimal for incidents at shallow to moderate depth since the residence time of gas bubbles is expected to be short (Reed et al., 2006).

2.2. Ice Present

The fate and behavior of oils in ice conditions is different from oil in temperate water with slower chemical and biological reactions. Broken ice occurs in the Chukchi Sea during fall freezeup and spring breakup. The ice would restrict the oil somewhat and reduce spreading (Gjosteen and Loset, 2004; Faksness et al., in press). Weathering of oil in high ice concentrations (70-90%) is significantly slower compared to weathering in open water (Brandvik et al. 2010). But unless the oil is frozen into the ice, evaporation would continue to occur. Dispersion and emulsification rates are lower in broken ice than in open water. During fall freezeup, the oil would freeze into the grease ice and slush before ice sheeting occurs (NORCOR, 1975). Winds and storms could break up and disperse the ice and oil until the next freezing cycle. These freezing cycles could be hours or days.

Faksness and Brandvik (2008a) studied the dissolved water-soluble components encapsulated in first-year sea ice. Their data show a concentration gradient from the surface of the ice to the bottom, indicating there is transport of the dissolved components through brine channels. Field studies also showed that high air temperature leads to more porous ice, and the dissolved water-soluble components leak out rapidly; however, under cold air temperatures and less porous ice, the water-soluble components leak more slowly and have potentially toxic concentrations (Faksness and Brandvik, 2008b).

During deep winter the oil would freeze into the forming and existing ice sheets (Dickens, 2011; Mar, Inc., et al., 2011). Then, in late spring and summer, the unweathered oil would melt out of the ice at different rates, depending on whether it is encapsulated in multiyear or first-year ice, and depending on when the oil was frozen into the ice. In first-year ice, most (85%) of the oil spilled at any one time would percolate up to the ice surface over about a 10-day period (Dickens, Buist and Pistruzak, 1981; Dickins et al., 2008; NORCOR, 1975; Nelson and Allen, 1981). In approximately mid-July, the oil pools would drain into the water among the floes of the opening ice pack. Thus, in first-year ice, oil would be pooled on the ice surface for up to 30 days before being discharged from the ice surface to the water surface. The pools on the ice surface would concentrate the oil, but only to about 2 centimeters thick, allowing evaporation of 5% of the oil, the part of the oil composed of the lighter, more toxic components. By the time the oil is released from the melt pools on the ice surface, evaporation will have almost stopped, with only an additional 4% of the spilled oil evaporating during an additional 30 days on the water.

2.3. Open Water

The oil would move with the currents, ice, and winds. In addition to sunlight breaking down the oil, sunlight also has the potential to cause photo-enhanced toxicity (Barron et al., 2008).

2.4. Persistence

The Sale 193 FEIS (USDOI, MMS, 2007a; incorporated by reference) Appendix A, Section B.2 discusses shoreline type and Table A.1-8 shows the percent environmental sensitivity index (ESI) of the adjacent coastlines. Many coastlines of the Chukchi and Beaufort have high ESI shoreline types which means oil could weather very slowly. Shoreline oiling and persistence depends on a number of factors (Etkin, McCay and Michel, 2007). Certain factors allow for some spills to persist in the shoreline and adjacent intertidal areas for decades (Li and Boufadel, 2010; Owens, Taylor and Humphrey, 2008; Peacock et al., 2005). A recent study of biodegradation in the Arctic showed that as temperature increased in the Arctic summer biodegradation increased (Chang, Whyte and Ghoshal, 2011).

Dispersion of oil droplets and suspension of sediments from turbulence at the discharge location could facilitate the formation of oil sediment particulate matter, which could be deposited on the seafloor in the vicinity of the discharge location (Lee and Page, 1997; Payne, Clayton and Kirstein, 2003; Sterling et al., 2004; Farwell et al., 2009). The losses of hydrocarbons from both abiotic and biotic weathering in subsea Arctic sediments could be slow (Atlas, Horowitz and Dushoshi, 1978; Payne, Clayton and Kirstein, 2003).

Lee and Page (1997) reviewed several large spills and estimated 1–13% of the spilled oil entered subtidal zones with an order of magnitude less hydrocarbon concentration than found in intertidal sediments. Exceptions (for less hydrocarbon concentrations) were semi-enclosed areas with clay-silt surface sediments and high concentrations of suspended sediments (Page et al., 1989). Biodegradaion and weathering of intertidal areas in cold waters were on the order of months to decades (Atlas, Boehm and Calder, 1981; Prince et al., 2003). Oil persistence in subtidal areas would be weeks to years, except for specific areas described above (Lee and Page, 1997).

3. Very Large Oil-Spill Weathering

The weathering for very large spills followed the same methodology described in the Sale 193 FEIS (Appendix A, Section B.4), and the results for very large oil spills are described below. The oil weathering input parameters are as follows:

- The crude oil properties will be similar to a light crude oil of 35 API.
- The size of the crude spill ranges from 60,000–20,000 bbl per day.
- The wind, wave, and temperature conditions are as described.
- The spill is a subsurface spill at approximately 40 m (meters).
- Meltout spills occur into 50% ice cover.
- The properties predicted by the model are those of the thick part of the slick.
- The spill occurs as a long duration spill estimated at a daily rate.
- The fate and behavior are as modeled (Tables B-3 and B-4).
- The oil spill persists for up to 30 days in open water and ice under 4 m/s (meters/second) wind.

For purposes of analysis, we look at the mass balance of the VLOS; in other words, how much is evaporated, dispersed, and remaining. At the average wind speeds over the Sale 193 area, dispersion is estimated to be moderate, ranging from 2-33% (Tables B-3 and B-4). Approximately one third of the spill evaporates within 30 days with most of the evaporation taking place within one day during summer and winter.

However, at higher wind speeds (e.g., 10-15 m/s wind speed) and during summer, the slick would be dispersed and evaporated from the sea surface within a day. Natural dispersion would take place if there was sufficient energy on the sea surface, such as breaking waves. The waves would break the oil slick into small droplets, typically with a diameter of 1–1000 μm (micrometers), which are mixed into the water masses (Reed et al., 2005). The largest droplets will resurface causing a thin monomolecular layer or sheen behind the main body of the oil spill. "Remaining" (in Tables B-3 and B-4) refers to the oil remaining after subtracting the above estimates from the total estimated release. Possible fates of the remaining oil include remaining in the water column, settling to the sea floor, mixing with sediment, ingestion by microbes, or beaching on the shoreline and subsequent removal during shore cleanup activities or burial within the beach profile.

Table B-3. Fate and behavior of a hypothetical 20,000-bbl crude oil spill in the Chukchi Sea.

	Summer Spill[1]				Meltout Spill[2]			
Time After Spill (Days)	1	3	10	30	1	3	10	30
Oil Remaining (%)	61	53	36	13	67	58	47	35
Oil Dispersed (%)	10	16	29	50	4	10	17	27
Oil Evaporated (%)	29	31	35	37	29	32	36	38

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Table B- 4. Fate and behavior of a hypothetical 60,000-bbl crude oil spill in the Chukchi Sea.

	Summer Spill[1]				Meltout Spill[2]			
Time After Spill in Days	1	3	10	30	1	3	10	30
Oil Remaining (%)	68	62	51	30	71	65	58	48
Oil Dispersed (%)	5	8	16	33	2	5	9	15
Oil Evaporated (%)	27	30	33	37	27	30	33	37

Notes: Calculated with the SINTEF oil-weathering model Version 3.0 of Reed et al. (2005) and a 35 API crude oil.
[1] Summer (Open Water), Spill is assumed to occur in open water, 8-knot wind speed, 2 degrees Celsius, 0.4-meter wave height.
[2] Meltout Spill (Oil melts out of sea ice). Spill is assumed to occur into first-year pack ice, freeze into ice and melt out, pools 2-centimeter thick on ice surface for 2 days at -1 degrees Celsius prior to meltout into 50% ice cover, 10-knot wind speed, and 0.1 meter wave heights.
Source: USDOI, BOEMRE, Alaska OCS Region (2011)

4. Oil Spill Trajectory Model Overview

The Sale 193 FEIS, Appendix A, Section C, Estimates of Where a Large Oil Spill May Go is incorporated by reference and briefly summarized. The Sale 193 FEIS oil spill trajectory analysis used 13 launch areas (LAs) within the sale area representing the places where a hypothetical spill could originate from an exploration or development activity. The analysis also used 87 environmental resource areas (ERAs), 126 land segments (LSs), 39 boundary segments (BSs) and 15 grouped land segments (GLSs) representing biological, economic or social resources within and adjacent to the sale area (Figures B-1 to B-10; USDOI, MMS, 2007, Tables A.1-12 to A.1-16). The larger scope of the VLOS scenario warranted consideration of more ERAs than were used in the Sale 193 FEIS OSRA analysis. Analysts were asked to identify additional ERAs useful for understanding the potential impacts of a VLOS. Three additional ERAs (74, 83 and 91) for whales in Russian waters were incorporated from Table A.1-15 in the Arctic Multi-Sale Draft EIS (USDOI, MMS, 2008a) and EFH polygons (Appendix C) were developed and analyzed because conditional probability data was not available from the Sale 193 FEIS.

The Sale 193 FEIS (Appendix A, Section C.1.f.) describes the general circulation models used for oil spill trajectories and is incorporated by reference and summarized as follows. Offshore, the model is based on a three dimensional general circulation model (Haidvogel, Hedstrom, and Francis, 2001). Landfast ice is applied as a mask October through June. Winds are derived from a 15 year reanalysis of the TOVs data.

The Sale 193 FEIS (Appendix A, Section C.2) describes the oil-spill-trajectory model assumptions and are tailored to the very large oil spill analysis below:

- Very large oil spills occur in the hypothetical launch areas.
- A very large oil spill reaches the water.
- An oil spill frozen in or on top of the landfast ice does not move until the ice moves or the ice melts out releasing the oil.

- Very large oil spills persist long enough for trajectory modeling for up to 360 days, if the spills are encapsulated in ice and melt out.
- Very large oil spills occur and move without consideration of weathering of the oil. The oil spills are simulated a point with no mass or volume.
- The weathering of the oil is estimated in the stand-alone SINTEF OWM model.
- Oil spills occur and move without any cleanup. The model does not simulate cleanup scenarios. The oil-spill trajectories move as though no booms, skimmers, or any other response action is taken.
- Oil spills stop when the oil contacts the mainland coastline. Oil spills do not stop when the oil contacts the offshore barrier islands in Stefansson Sound.

Uncertainties exist about oil spills. These uncertainties include:

- the actual size of the oil spill, should it occur;
- whether the spill reaches the water;
- whether the spill is instantaneous or a long-term leak;
- the wind, current, and ice conditions at the time of a possible oil spill;
- how effective cleanup is;
- the exact characteristics of crude oil at the time of the spill;
- how crude oil will spread; and
- whether or not exploration or development and production occurs.

4.1. Conditional Probabilities

A conditional probability is a probability that is conditioned on a spill occurring. In other words it assumes a spill occurs and does not factor in the probability of such a spill occurring. This section explains how the application of conditional probabilities changes for a large oil spill analyzed in the Sale 193 FEIS and the VLOS analyzed here.

Large Oil Spill

The Sale 193 FEIS Appendix A.2 presented conditional probability results. Assuming a large oil spill occurs the conditional probability tables show the calculated probability (expressed as percent chance) that, at a given launch area, within a specified period of time, a large oil spill will contact a particular environmental resource area, land segment or boundary segment. These calculated probabilities are used to estimate the chance that any one trajectory of a large oil spill would contact an environmental resource area, land segment or boundary segment.

The conditional probabilities of a large spill contacting specific environmental, social, or economic resources in a given time frame during a particular season were analyzed in each resource in the Sale 193 FEIS. In light of these conditional probabilities the effects from a large oil spill were discussed for specific resources in the Sale 193 FEIS (Sections IV.C.1.c[4][b], IV.C.1.d[3][d], IV.C.1.e[4] IV.C.1.f[1][g], IV.C.1.g[3][g], IV.C.1.h[4], IV.C.1.h[6][e], and IV.C.1.l[1][b]).

Very Large Oil Spill

Assuming a hypothetical high volume and long duration oil release occurs resulting in a VLOS, this section describes how the conditional probabilities from the Sale 193 FEIS for a large oil spill should be considered and applied for a VLOS, and where an offshore VLOS may go over longer time periods of within 60 and within 360 days.

In the Sale 193 FEIS a large spill would be represented by a single trajectory. A very large oil spill, of long duration, would be represented by numerous trajectories. In the current SEIS VLOS analysis a spill would be represented by numerous trajectories.

In a large spill trajectory analysis it is not estimated that any one trajectory brings oil to that location. Rather, the number of trajectories contacting an individual resource over the total number of trajectories launched is used to calculate the percent chance of a hypothetical large spill trajectory contacting that resource. For example, if 1,000 large oil spill trajectories are launched and 500 of the trajectories contact that location, there is a 50% chance of a large spill contacting that location.

A long duration VLOS would consist of a spill occurring continuously for up to 74 days and therefore is more like a batch spill launched every day or so. There would be multiple trajectories over time with each trajectory launched regularly as the well continued to flow. Each trajectory would bring some fraction of the oil spill to that specific resource or location. The multiple trajectories representing a VLOS would change how the conditional probabilities are interpreted. The conditional probabilities would represent how many trajectories come to that location described as percent trajectories (number of trajectories contacting/total number of trajectories launched). For example, if 1,000 trajectories are launched and 500 of the trajectories contact that location, then 50% of the trajectories would bring oil to that location. The terminology used hereafter is percentage of trajectories contacting.

The Sale 193 FEIS conditional probabilities are used estimate the percentage of trajectories contacting biological, social, and economic resources of concern in and adjacent to the Sale 193 area from a VLOS. The OSRA results from the Sale 193 FEIS were used for the VLOS by considering the conditional results as percentage of trajectories contacting. The Arctic OSRA calculations are run for as long as 360 days and were appropriate for very large oil spills with long duration. This analysis summarizes the results of each oil spill trajectory simulation tracked up to 60 and 360 days. These VLOS results pertain to oil spill trajectories from the 13 LAs in the Sale 193 FEIS to various land segments and environmental resource areas.

The trajectories age while they are in the water/ice. For each day the the hypothetical spill is in the water, the spill ages up to a total of 30 days. While the spill is in the ice (≥80% concentration), the aging process is suspended. The maximum time allowed for the transport of oil in the ice is 360 days after which the trajectory is terminated. Each trajectory was allowed to continue for as long as 30 days in ice free water. However, if the hypothetical trajectory contacted the shoreline sooner than 30 days after the start of the trajectory, the trajectory was then terminated, and the contact was recorded.

4.2. Oil Spill Trajectory Results

The percentages of trajectories contacting resources (ERA, LS, GLS, or BS), assuming a VLOS has occurred, is taken from the oil-spill-trajectory model results summarized below and listed in Appendix B, Tables B-7 through B-28 at the end of this document.

Section IV.D of this document presents a comparison between the hypothetical launch areas and seasons, and, below, the oil spill trajectory results within 60 days and 360 days for summer and winter are presented. For specific analysis of oil spill trajectory results with regard to each individual biological, social, or economic resource, please see Section IV.E.

4.3. Generalities Through Time

Below, we summarize the percentages of trajectories contacting resources (ERA, LS, GLS, or BS) during summer within 60 days, and during summer and winter within 360 days.

60 Days. During summer, <0.5–2% of the trajectories from LA4 or LA9 contact LSs 27 or 32–39 (Rigol, Eynenekvyk, Enumino, Mys Serdtse-Kamen, Uelen, Russia) and <0.5–3% of the trajectories contact LSs 64–67(Point Hope–Ayugatak Lagoon) (see Table B-9). During summer, <0.5–6% of the trajectories from LA4–LA13 contact at least one individual LS within LSs 63–89 (Cape Seppings–Ikpikpuk River) (see Table B-9). Less than 0.5% of the trajectories from LA1 and LA2 contact an individual land segment within 60 days over summer (Table B-9).

Launch areas adjacent to or on top of ERAs have the highest percent chance of trajectories contacting these ERAs. During summer, <0.5–60% of trajectories from LA1–LA13 contact individual ERAs (Table B-7). During summer, 2–28% of the trajectories contact land from LA1–13 (Table B-7). During summer, <0.5%–3% of the trajectories contact boundary segments from LA1–13 (Table B-13).

360 Days. During summer, <0.5–3% of the trajectories from LA4 or LA9 contact LSs 27–39 (Rigol, Uelen, Russia) and <0.5–3% of the trajectories contact LSs 64–67 (Point Hope–Ayugatak Lagoon) (Table B-10). During summer, <0.5-10% of the trajectories from LA4–LA13 contact at least one individual LSs 64–91 (Point Hope–Pitt Point) (Table B-10). Less than 0.5% of the trajectories from LA1 contact an individual land segment within 360 days over summer (Table B-10). During summer, <0.5%–12% of the trajectories contact boundary segments from LA1–13 (Table B-14).

During winter, <0.5–1% of the trajectories from LA1 or LA2 contact LS7, LS8, or LS27 (E. Wrangel Island, Rigol). During winter <0.5–5% of the trajectories from LA4 or LA9 contact LSs 27–39 (Rigol-Uelen, Russia) and <0.5-1% of the trajectories contact LS 64–65(Kukpuk River–Cape Lisburne) (Table B-17). During winter, <0.5–5% of the trajectories from LA4–LA13 contact at least one individual LS within LSs 70–87 (Kuchiak Creek to Kulgurak Island) (Table B-17). During winter <0.5%–18% of the trajectories contact boundary segments from LA1–13 (Table B-22).

Launch areas adjacent to or on top of ERAs have the highest percentage of trajectories contacting ERAs. During summer, <0.5–62% of trajectories from launch areas LA1–LA13 contact individual ERAs (Table B-8). During summer, 3-42% of the trajectories contact land from LA1–13(Table B-8). During winter, <0.5–68% of trajectories from launch areas LA1–LA13 contact individual ERA’s (Table B-16). During winter, 6–36% of the trajectories contact land from LA1–13 (Table B-16).

4.4. Cumulative Area Contacted by a Very Large Oil Spill

To provide a representation of the potential cumulative area contacted by a VLOS over time and space, BOEMRE created a grid system of cells, each cell defined as 0.1 degree latitude by 0.33333 degree longitude. As the oil spill trajectories were computed by the model, contact with the grid cells was tabulated. For each trajectory, the cumulative area of all grid cells contacted was then calculated for the given time period.

The cumulative area is discontinuous because it does not represent the entire area contacted by the VLOS at any one time; rather, it is a cumulative estimate of the area contacted by a VLOS over six time periods (3, 10, 30, 60, 180, or 360 days). Tables B-5 and B-6 show the results for summer and winter seasons, respectively. The discontinuous cumulative area rises rapidly between 3 and 30 days, and then more slowly between 30 and 360 days. For the discontinuous area contacted after 30 days, this means the particle—a point along the oil spill trajectory—persisted (did not disperse) more than 30 days on the surface of the water and was concentrated in the ice until the ice melted out. Interestingly, the estimates for discontinuous cumulative area during summer open water are similar in size to NOAA fisheries closures for similar timeframes during the DWH event (NOAA, 2011).

Table B-5. Discontinuous Area Contacted in Square Kilometers by a Very Large Crude Oil Spill in the Chukchi Sea during Summer.

Days	LA01	LA02	LA03	LA04	LA05	LA06	LA07
3	47,300	36,700	28,500	39,100	48,400	40,600	28,100
10	113,800	92,000	76,300	107,100	116,500	94,800	68,900
30	296,000	245,900	201,300	303,500	302,100	241,000	183,900
60	340,600	294,500	279,500	353,900	364,100	322,500	305,600
180	414,400	397,000	392,600	401,400	440,800	440,900	391,700
360	459,000	437,900	430,900	416,800	477,800	491,800	334,600
Days	**LA08**	**LA09**	**LA10**	**LA11**	**LA12**	**LA13**	
3	29,500	41,200	48,800	48,100	31,300	31,000	
10	78,400	106,000	111,500	103,400	74,800	67,300	
30	215,700	233,800	277,000	253,600	189,600	191,700	
60	364,200	245,800	331,000	335,400	311,300	344,200	
180	491,000	260,000	379,600	444,000	402,800	484,700	
360	547,600	264,500	400,700	476,200	450,400	545,100	

Source: USDOI, BOEMRE, Alaska OCS Region (2011)

Table B-6. Discontinuous Area Contacted in Square Kilometers by a Very Large Crude Oil Spill in the Chukchi Sea during Winter.

Days	LA01	LA02	LA03	LA04	LA05	LA06	LA07
3	53,700	34,900	25,900	43,800	44,800	36,800	27,600
10	120,900	82,200	63,000	131,100	100,500	77,600	62,300
30	276,800	164,000	108,500	316,500	217,400	138,900	127,100
60	326500	211,600	162,200	385,600	297,700	201,700	176,600
180	390,400	309,000	292,600	453,400	381,900	331,500	334,600
360	438,800	379,000	368,400	507,200	440,500	411,000	406,400
Days	**LA08**	**LA09**	**LA10**	**LA11**	**LA12**	**LA13**	
3	31,500	44,100	48,800	40,800	30,100	32,000	
10	83,100	121,900	104,000	79,400	65,200	71,800	
30	196,900	250,100	246,100	154,600	150,500	170,000	
60	270,000	300,100	339,400	230,800	218,900	251,200	
180	410,500	359,600	414,900	348,400	372,900	409,700	
360	474,900	379,300	484,700	413,700	446,400	481,300	

Source: USDOI, BOEMRE, Alaska OCS Region (2011)

TABLES

Table B-7. Fraction of a Very Large Oil Spill (expressed as a percentage) starting at a given location that will contact a certain environmental resource area within 60 days during summer. (Chukchi Sea Sale 193, Table A.2-28)

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
—	LAND	2	2	2	8	10	7	8	18	21	27	27	28	32
1	Kasegaluk Lagoon	-	-	-	3	4	1	-	-	2	14	16	5	-
2	Point Barrow, Plover Islands	-	-	-	-	-	-	2	9	-	-	-	-	8
3	ERA 3	-	-	-	2	-	-	-	-	7	2	-	-	-
4	ERA 4	-	-	-	-	-	-	-	-	3	1	-	-	-
6	ERA 6	1	2	2	2	6	8	11	15	-	3	16	35	36
10	Ledyard Bay Spectacled Eider Critical Habitat	1	-	-	7	8	2	-	-	11	38	22	4	-
11	Wrangel Island12 nmi Buffer	2	1	1	1	1	1	-	-	-	-	-	-	-
13	ERA 13	-	-	-	-	-	-	-	-	-	-	-	-	-
14	Cape Thompson Seabird Colony Area	-	-	-	2	1	-	-	-	16	6	1	-	-
15	Cape Lisburne Seabird Colony Area	-	-	-	4	3	-	-	-	22	19	4	-	-
16	ERA 16	-	-	-	1	-	-	-	-	5	1	-	-	-
18	ERA 18	3	1	-	16	7	1	-	-	42	19	5	1	-
19	Chukchi Spring Lead 1	-	-	-	-	-	-	-	-	1	-	-	-	-
20	Chukchi Spring Lead 2	-	-	-	-	-	-	-	-	-	3	1	-	-
21	Chukchi Spring Lead 3	-	-	-	-	-	-	-	-	-	2	3	-	-
22	Chukchi Spring Lead 4	-	-	-	-	-	-	-	-	-	-	3	3	-
23	Chukchi Spring Lead 5	-	-	-	-	-	-	-	-	-	-	-	2	2
24	Beaufort Spring Lead 6	-	-	-	-	-	-	-	1	-	-	-	-	1
25	Beaufort Spring Lead 7	-	-	-	-	-	-	-	-	-	-	-	-	1
29	Ice/Sea Segment 1	-	-	-	-	-	-	1	5	-	-	-	1	5
30	Ice/Sea Segment 2	-	-	-	-	-	-	1	2	-	-	-	-	2
31	Ice/Sea Segment 3	-	-	-	-	-	-	1	2	-	-	-	-	1
32	Ice/Sea Segment 5	-	-	-	-	-	-	-	1	-	-	-	-	-
35	ERA 35	3	5	7	2	8	16	20	20	-	2	22	60	50
36	ERA 36	5	4	2	17	26	11	4	1	5	38	51	16	3
38	Pt. Hope Subsistence Area	-	-	-	1	1	-	-	-	8	6	1	-	-
39	Point Lay Subsistence Area	-	-	-	3	5	2	-	-	2	18	16	3	-
40	Wainwright Subsistence Area	1	1	-	3	8	5	2	2	1	9	23	27	7
42	Barrow Subsistence Area 2	-	-	-	-	-	-	2	12	-	-	-	1	10
45	ERA 45	-	-	-	3	2	-	-	-	26	13	3	-	-
46	Herald Shoal Polynya	7	3	1	21	9	3	1	-	3	6	4	1	-
47	Ice/Sea Segment 10	11	5	2	22	31	9	2	1	1	6	12	5	1
48	Ice/Sea Segment 11	7	15	18	2	17	47	17	7	-	4	20	15	8
49	Hanna's Shoal Polynya	7	19	46	1	6	22	24	15	-	2	7	8	9
50	Ice/Sea Segment 12	2	5	6	1	5	16	13	5	-	1	13	38	13
51	Ice/Sea Segment 13	1	2	3	-	2	7	10	5	-	-	5	34	26
52	Ice/Sea Segment 14	-	1	2	-	-	2	7	29	-	-	1	4	29
53	Ice/Sea Segment 15	-	-	-	-	-	-	2	4	-	-	-	-	3
54	Ice/Sea Segment 16a	-	-	-	-	-	-	1	3	-	-	-	-	1
55	Ice/Sea Segment 17	-	-	-	-	-	-	-	1	-	-	-	-	-
56	ERA 56	7	14	22	1	9	40	40	15	-	2	19	56	27
59	ERA 59	-	-	-	1	-	-	-	-	2	1	-	-	-
61	ERA 61	-	-	-	-	-	-	-	-	3	1	-	-	-
63	ERA 63	3	2	1	-	-	-	-	1	-	-	-	-	-
64	Peard Bay	-	1	2	-	2	4	7	8	-	-	3	15	23
65	Smith Bay	-	-	-	-	-	-	-	1	-	-	-	-	-
66	ERA 66	-	-	-	-	-	-	-	4	-	-	-	-	2
70	ERA 70	9	10	7	-	1	3	1	1	-	-	1	1	1

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
82	ERA 82	-	-	-	-	-	-	-	-	1	-	-	-	-
99	ERA 99	5	5	3	21	36	15	4	1	6	54	70	18	3

Notes: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area. . Rows with all values less than 0.5 percent are not shown.

Table B-8. Fraction of a Very Large Oil Spill (expressed as a percentage) starting at a given location that will contact a certain environmental resource area within 360 days during summer (Chukchi Sea Sale 193, Table A.2-30).

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
—	LAND	4	3	6	12	13	10	17	34	28	31	30	34	42
1	Kasegaluk Lagoon	-	-	-	3	4	1	-	-	2	14	16	5	-
2	Point Barrow, Plover Islands	-	-	2	-	-	2	6	13	-	-	-	1	10
3	ERA 3	-	-	-	2	-	-	-	-	7	2	-	-	-
4	ERA 4	-	-	-	-	-	-	-	-	3	1	-	-	-
6	ERA 6	2	3	6	2	8	12	20	22	-	3	18	39	40
10	Ledyard Bay Spectacled Eider Critical Habitat	1	-	-	8	8	2	1	1	11	38	22	4	-
11	Wrangel Island 12nmi Buffer	2	1	1	1	1	1	-	-	-	1	1	-	-
13	ERA 13	-	-	-	-	-	-	-	-	-	-	-	-	-
14	Cape Thompson Seabird Colony Area	-	-	-	2	1	-	-	-	16	6	1	-	-
15	Cape Lisburne Seabird Colony Area	-	-	-	4	3	-	-	-	22	19	4	-	-
16	ERA 16	-	-	-	1	-	-	-	-	7	2	-	-	-
18	ERA 18	3	1	-	16	7	1	-	-	42	20	5	1	-
19	Chukchi Spring Lead 1	-	-	-	-	-	-	-	-	1	-	-	-	-
20	Chukchi Spring Lead 2	-	-	-	-	-	-	-	-	-	3	1	-	-
21	Chukchi Spring Lead 3	-	-	-	-	-	-	-	-	-	2	3	-	-
22	Chukchi Spring Lead 4	-	-	-	-	1	-	-	-	-	-	4	4	-
23	Chukchi Spring Lead 5	-	-	-	-	-	-	-	-	-	-	-	2	2
24	Beaufort Spring Lead 6	-	1	1	-	-	2	3	3	-	-	1	1	4
25	Beaufort Spring Lead 7	-	2	4	-	1	4	6	5	-	-	1	2	4
26	Beaufort Spring Lead 8	-	-	-	-	-	-	1	1	-	-	-	-	1
27	Beaufort Spring Lead 9	-	-	-	-	-	-	-	1	-	-	-	-	1
29	Ice/Sea Segment 1	-	-	1	-	-	1	3	6	-	-	-	1	6
30	Ice/Sea Segment 2	-	-	1	-	-	1	4	4	-	-	1	1	2
31	Ice/Sea Segment 3	-	-	1	-	-	1	3	3	-	-	-	-	1
32	Ice/Sea Segment 4	-	-	-	-	-	-	1	2	-	-	-	-	-
35	ERA 35	5	7	10	3	10	19	24	23	-	2	24	62	52
36	ERA 36	5	4	3	18	27	11	4	1	5	39	51	17	3
38	Pt. Hope Subsistence Area	-	-	-	2	1	-	-	-	8	6	2	-	-
39	Point Lay Subsistence Area	-	-	-	4	5	2	1	-	2	19	16	3	-
40	Wainwright Subsistence Area	1	1	1	4	9	6	4	4	1	10	25	29	9
41	Barrow Subsistence Area 1	-	-	-	-	-	-	-	-	-	-	-	1	1
42	Barrow Subsistence Area 2	-	-	1	-	-	1	4	14	-	-	1	2	11
45	ERA 45	-	-	-	3	2	-	-	-	26	13	3	-	-
46	Herald Shoal Polynya	7	3	1	22	10	3	1	-	3	6	4	1	-
47	Ice/Sea Segment 10	11	5	2	22	31	9	2	1	1	6	12	5	1
48	Ice/Sea Segment 11	8	17	20	3	18	49	22	10	-	5	22	20	11
49	Hanna's Shoal Polynya	10	23	50	2	10	29	34	23	-	4	12	21	19
50	Ice/Sea Segment 12	4	8	9	1	7	19	17	8	-	2	15	41	16
51	Ice/Sea Segment 13	2	4	5	1	4	9	15	9	-	1	8	38	29
52	Ice/Sea Segment 14	1	3	5	-	1	5	11	30	-	-	2	6	30
53	Ice/Sea Segment 15	-	1	3	-	1	3	5	7	-	-	1	2	4
54	Ice/Sea Segment 16a	-	1	3	-	1	3	6	8	-	-	1	2	4
55	Ice/Sea Segment 17	-	-	-	-	-	1	2	2	-	-	-	-	1
56	ERA 56	8	16	24	2	11	42	43	16	-	2	20	57	28
58	Ice/Sea Segment 20a	-	-	1	-	-	-	1	5	-	-	-	-	3
59	ERA 59	-	-	-	1	-	-	-	-	2	1	-	-	-
60	Ice/Sea Segment 22	-	-	-	-	-	-	-	2	-	-	-	-	1
61	ERA 61	-	-	-	-	-	-	-	-	3	1	-	-	-

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
62	Ice/Sea Segment 24a	-	-	-	-	-	-	-	1	-	-	-	-	1
63	ERA 63	3	2	1	-	-	-	1	2	-	-	-	1	1
64	Peard Bay	1	2	4	-	2	6	13	12	-	-	4	18	25
65	Smith Bay	-	-	-	-	-	-	1	2	-	-	-	-	1
66	ERA 66	-	1	4	-	1	4	6	7	-	-	1	2	3
67	Herschel Island	-	-	-	-	-	-	-	1	-	-	-	-	-
68	Harrison Bay	-	-	-	-	-	-	-	1	-	-	-	-	-
69	Harrison Bay/Colville Delta	-	-	-	-	-	-	-	1	-	-	-	-	1
70	ERA 70	9	10	8	-	2	4	2	1	-	-	1	2	1
76	ERA 76	-	-	-	-	-	-	-	1	-	-	-	-	1
79	ERA 79	-	-	-	-	-	-	-	1	-	-	-	-	-
82	ERA 82	-	-	-	-	-	-	-	-	1	-	-	-	-
83	Kaktovik ERA	-	-	-	-	-	-	1	3	-	-	-	-	2
99	ERA 99	5	5	3	21	36	15	4	1	6	54	71	19	3

Notes: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area. . Rows with all values less than 0.5 percent are not shown.

Table B-9. Fraction of a Very Large Oil Spill (expressed as a percentage) starting at a given location that will contact a certain land segment within 60 days during summer (Chukchi Sea Sale 193, Table A.2-34).

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
8	E. Wrangel Island, Skeletov	-	-	-	-	-	-	-	-	-	-	-	-	-
27	Laguna Nut, Rigol'	-	-	-	1	-	-	-	-	1	-	-	-	-
32	Mys Dzhenretlen, Eynenekvyk	-	-	-	-	-	-	-	-	1	-	-	-	-
33	Neskan, Laguna Neskan	-	-	-	-	-	-	-	-	1	-	-	-	-
34	Tepken, Memino	-	-	-	-	-	-	-	-	1	-	-	-	-
35	Enurmino, Mys Neten	-	-	-	-	-	-	-	-	2	-	-	-	-
36	Mys Serdtse-Kamen	-	-	-	-	-	-	-	-	2	-	-	-	-
37	Chegitun, Utkan	-	-	-	-	-	-	-	-	2	-	-	-	-
38	Enmytagyn, Inchoun, Mitkulen	-	-	-	-	-	-	-	-	1	-	-	-	-
39	Cape Dezhnev, Naukan, Uelen	-	-	-	-	-	-	-	-	1	-	-	-	-
63	Asikpak Lag., Cape Seppings	-	-	-	-	-	-	-	-	-	-	-	-	-
64	Kukpuk River, Point Hope	-	-	-	-	-	-	-	-	3	2	-	-	-
65	Buckland, Cape Lisburne	-	-	-	1	-	-	-	-	2	2	1	-	-
66	Ayugatak Lagoon	-	-	-	-	-	-	-	-	1	1	1	-	-
67	Cape Sabine, Pitmegea River	-	-	-	-	-	-	-	-	1	1	-	-	-
68	Agiak Lagoon, Punuk Lagoon	-	-	-	-	-	-	-	-	-	1	-	-	-
69	Cape Beaufort, Omalik Lagoon	-	-	-	-	-	-	-	-	-	1	-	-	-
70	Kuchaurak and Kuchiak Creek	-	-	-	-	-	-	-	-	-	1	-	-	-
71	Kukpowruk River, Sitkok Point	-	-	-	-	-	-	-	-	-	2	1	-	-
72	Point Lay, Siksrikpak Point	-	-	-	-	-	-	-	-	-	3	1	-	-
73	Tungaich Point, Tungak Creek	-	-	-	-	1	-	-	-	-	4	2	-	-
74	Kasegaluk Lagoon, Solivik Isl.	-	-	-	1	1	-	-	-	-	3	4	1	-
75	Akeonik, Icy Cape	-	-	-	1	1	-	-	-	-	2	4	1	-
76	Avak Inlet, Tunalik River	-	-	-	-	-	-	-	-	-	-	1	1	-
77	Nivat Point, Nokotlek Point	-	-	-	-	1	-	-	-	-	1	2	1	-
78	Point Collie, Sigeakruk Point	-	-	-	-	1	-	-	-	-	-	2	2	-

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
79	Point Belcher, Wainwright	-	-	-	-	1	1	1	1	-	-	3	6	1
80	Eluksingiak Point, Kugrua Bay	-	-	-	-	-	1	-	1	-	-	1	4	2
81	Peard Bay, Point Franklin	-	-	-	-	1	1	-	-	-	-	1	4	1
82	Skull Cliff	-	-	-	-	-	-	-	-	-	-	-	2	3
83	Nulavik, Loran Radio Station	-	-	1	-	-	1	1	1	-	-	-	2	3
84	Will Rogers & Wiley Post Mem.	-	-	-	-	-	-	2	2	-	-	-	2	6
85	Barrow, Browerville, Elson Lag.	-	-	-	-	-	-	3	8	-	-	-	1	11
86	Dease Inlet, Plover Islands	-	-	-	-	-	-	1	2	-	-	-	-	2
87	Igalik & Kulgurak Island	-	-	-	-	-	-	-	1	-	-	-	-	1
88	Cape Simpson, Piasuk River	-	-	-	-	-	-	-	1	-	-	-	-	-
89	Ikpikpuk River, Point Poleakoon	-	-	-	-	-	-	-	1	-	-	-	-	-

Notes: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area. . Rows with all values less than 0.5 percent are not shown.

Table B-10. Fraction of a Very Large Oil Spill (expressed as a percentage) starting at a given location that will contact a certain land segment within 360 days during summer (Chukchi Sea Sale 193, Table A.2-36).

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA13
8	E. Wrangel Island, Skeletov	-	-	-	-	-	-	-	1	-	-	-	-	1
26	Ekugvaam, Kepin, Pil'khin	-	-	-	-	-	-	-	1	-	-	-	-	-
27	Laguna Nut, Rigol'	-	-	-	1	-	-	-	-	1	-	-	-	-
28	Vankarem,Vankarem Laguna	-	-	-	-	-	-	-	-	1	-	-	-	-
29	Mys Onman, Vel'may	-	-	-	-	-	-	-	-	1	-	-	-	-
30	Nutepynmin, Pyngopil'gyn	-	-	-	-	-	-	-	-	1	-	-	-	-
31	Alyatki, Zaliv Tasytkhin	-	-	-	-	-	-	-	-	1	-	-	-	-
32	Mys Dzhenretlen, Eynenekvyk	-	-	-	-	-	-	-	-	2	-	-	-	-
33	Neskan, Laguna Neskan	-	-	-	-	-	-	-	-	2	1	-	-	-
34	Tepken, Memino	-	-	-	-	-	-	-	-	2	-	-	-	-
35	Enurmino, Mys Neten	-	-	-	-	-	-	-	-	3	1	-	-	-
36	Mys Serdtse-Kamen	-	-	-	-	-	-	-	-	2	-	-	-	-
37	Chegitun, Utkan	-	-	-	-	-	-	-	-	2	-	-	-	-
38	Enmytagyn, Inchoun, Mitkulen	-	-	-	-	-	-	-	-	1	-	-	-	-
39	Cape Dezhnev, Naukan, Uelen	-	-	-	-	-	-	-	-	1	-	-	-	-
63	Asikpak Lag., Cape Seppings	-	-	-	-	-	-	-	-	-	-	-	-	-
64	Kukpuk River, Point Hope	-	-	-	-	-	-	-	-	3	2	-	-	-
65	Buckland, Cape Lisburne	-	-	-	1	1	-	-	-	2	2	1	-	-
66	Ayugatak Lagoon	-	-	-	-	-	-	-	-	1	1	1	-	-
67	Cape Sabine, Pitmegea River	-	-	-	-	-	-	-	-	1	1	-	-	-
68	Agiak Lagoon, Punuk Lagoon	-	-	-	-	-	-	-	-	-	1	-	-	-
69	Cape Beaufort, Omalik Lagoon	-	-	-	-	-	-	-	-	-	1	-	-	-
70	Kuchaurak and Kuchiak Creek	-	-	-	-	-	-	-	-	-	1	-	-	-
71	Kukpowruk River, Sitkok Point	-	-	-	-	-	-	-	-	-	2	1	-	-
72	Point Lay, Siksrikpak Point	-	-	-	-	-	-	-	-	-	3	1	-	-
73	Tungaich Point, Tungak Creek	-	-	-	1	1	-	-	-	-	4	2	-	-
74	Kasegaluk Lagoon, Solivik Isl.	-	-	-	1	1	-	-	-	-	3	4	1	-
75	Akeonik, Icy Cape	-	-	-	1	1	-	-	-	-	2	4	1	-
76	Avak Inlet, Tunalik River	-	-	-	-	-	-	-	-	-	-	1	1	-
77	Nivat Point, Nokotlek Point	-	-	-	-	1	-	-	-	-	1	2	1	-
78	Point Collie, Sigeakruk Point	-	-	-	-	1	-	-	-	-	-	3	3	-

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA13
79	Point Belcher, Wainwright	-	-	-	-	1	2	1	1	-	-	3	6	2
80	Eluksingiak Point, Kugrua Bay	-	-	-	-	1	1	1	1	-	-	2	5	3
81	Peard Bay, Point Franklin	-	-	-	-	1	1	1	-	-	-	2	4	2
82	Skull Cliff	-	-	-	-	-	-	-	1	-	-	1	3	3
83	Nulavik, Loran Radio Station	-	-	1	-	1	1	1	1	-	-	-	2	3
84	Will Rogers & Wiley Post Mem.	-	1	2	-	-	2	5	5	-	-	1	3	7
85	Barrow, Browerville, Elson Lag.	-	-	1	-	-	1	5	10	-	-	-	2	13
86	Dease Inlet, Plover Islands	-	-	-	-	-	-	1	3	-	-	-	-	3
87	Igalik & Kulgurak Island	-	-	-	-	-	-	-	2	-	-	-	-	1
88	Cape Simpson, Piasuk River	-	-	-	-	-	-	-	1	-	-	-	-	-
89	Ikpikpuk River Point Poleakoon	-	-	-	-	-	-	-	1	-	-	-	-	-
91	Lonely, Pitt Point, Pogik Bay	-	-	-	-	-	-	-	1	-	-	-	-	1

Notes: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area. . Rows with all values less than 0.5 percent are not shown.

Table B-11. Fraction of a Very Large Oil Spill (expressed as a percentage) starting at a given location that will contact a certain grouped land segment within 60 days during summer (Chukchi Sea Sale 193, Table A.2-40).

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
84	Wrangel Is Nat Res Natural World Heritage Site	1	1	-	1	1	-	-	-	-	-	-	-	-
88	Alaska Maritime National Wildlife Refuge	-	-	-	1	-	-	-	-	3	2	1	-	-
89	National Petroleum Reserve Alaska	-	-	1	-	2	3	2	8	-	1	7	14	13
90	Kasegaluk Lagoon Special Use Area	-	-	-	-	1	-	-	-	-	1	3	2	-
91	Teshekpuk Lake Special Use Area	-	-	-	-	-	-	-	1	-	-	-	-	-
95	Russia Chukchi Coast	1	1	-	4	2	-	-	-	12	3	1	-	-
96	United States Chukchi Coast	1	1	1	5	9	6	4	5	9	24	26	26	17
97	United States Beaufort Coast	-	-	1	-	-	-	4	14	-	-	-	1	15

Notes: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area. P = Pipeline. Rows with all values less than 0.5 percent are not shown.

Table B-12. Fraction of a Very Large Oil Spill (expressed as a percentage) starting at a given location that will contact a certain grouped land segment within 360 days during summer (Chukchi Sea Sale 193, Table A.2-42).

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
84	Wrangel Is Nat Res Natural World Heritage Site	1	1	1	1	1	1	1	3	-	1	1	-	2
88	Alaska Maritime National Wildlife Refuge	-	-	-	1	1	-	-	-	3	2	1	-	-
89	National Petroleum Reserve Alaska	-	1	2	1	3	4	5	12	-	2	8	17	16
90	Kasegaluk Lagoon Special Use Area	-	-	-	-	1	-	-	-	-	1	3	2	-
91	Teshekpuk Lake Special Use Area	-	-	-	-	-	-	1	3	-	-	-	-	1
95	Russia Chukchi Coast	2	2	1	6	2	1	1	6	19	6	1	1	3
96	United States Chukchi Coast	1	2	3	6	11	8	9	9	9	25	28	31	20
97	United States Beaufort Coast	-	-	2	-	-	2	7	20	-	-	-	3	19

Notes: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area. Rows with all values less than 0.5 percent are not shown.

Table B-13. Fraction of a Very Large Oil Spill (expressed as a percentage) starting at a given location that will contact a certain boundary segment within 60 days during summer (Chukchi Sea Sale 193, Table A.2-46).

ID	Boundary Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
2	Bering Strait	-	-	-	-	-	-	-	-	1	-	-	-	-
16	Chukchi Sea	1	1	1	-	-	-	-	-	-	-	-	-	-
17	Chukchi Sea	1	1	1	-	-	1	-	-	-	-	-	-	-
18	Chukchi Sea	1	3	4	-	2	3	3	2	-	1	2	1	1
19	Chukchi Sea	1	2	3	-	1	1	3	2	-	-	1	1	1
20	Chukchi Sea	1	1	1	-	-	-	1	1	-	-	-	-	-
21	Chukchi Sea	-	-	1	-	-	-	1	1	-	-	-	-	-
22	Chukchi Sea	-	-	-	-	-	-	-	1	-	-	-	-	-
23	Beaufort Sea	-	-	-	-	-	-	1	1	-	-	-	-	-
24	Beaufort Sea	-	-	-	-	-	-	-	1	-	-	-	-	1
25	Beaufort Sea	-	-	-	-	-	-	-	1	-	-	-	-	-
26	Beaufort Sea	-	-	-	-	-	-	1	1	-	-	-	-	1

Notes: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area. Rows with all values less than 0.5 percent are not shown.

Table B-14. Fraction of a Very Large Oil Spill (expressed as a percentage) starting at a given location that will contact a certain boundary segment within 360 days during summer (Chukchi Sea Sale 193, Table A.2-48).

ID	Boundary Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
2	Bering Strait	-	-	-	-	-	-	-	-	1	-	-	-	-
16	Chukchi Sea	2	1	1	-	-	-	-	-	-	-	-	-	-
17	Chukchi Sea	1	2	3	-	1	2	1	-	-	-	1	-	-
18	Chukchi Sea	3	5	8	1	5	8	9	6	-	3	7	7	5
19	Chukchi Sea	3	7	10	1	5	8	12	8	-	3	6	9	8
20	Chukchi Sea	4	7	8	1	5	8	6	4	-	1	5	6	6
21	Chukchi Sea	1	1	4	-	-	2	2	3	-	-	1	1	2
22	Chukchi Sea	-	-	1	-	-	-	1	1	-	-	-	1	1
23	Beaufort Sea	1	1	3	-	-	1	2	2	-	-	-	1	1
24	Beaufort Sea	-	-	1	-	-	-	1	1	-	-	-	-	1
25	Beaufort Sea	-	1	1	-	-	2	1	1	-	-	1	2	1
26	Beaufort Sea	-	1	2	-	-	1	3	2	-	-	-	1	2
27	Beaufort Sea	-	-	1	-	-	-	1	2	-	-	-	-	1
28	Beaufort Sea	-	-	-	-	-	-	-	1	-	-	-	-	-
30	Beaufort Sea	-	-	-	-	-	-	-	1	-	-	-	-	-
31	Beaufort Sea	-	-	-	-	-	-	-	1	-	-	-	-	-
34	Beaufort Sea	-	-	-	-	-	-	1	1	-	-	-	-	1
35	Beaufort Sea	-	-	-	-	-	-	-	1	-	-	-	-	1

Notes: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area. Rows with all values less than 0.5 percent are not shown.

Table B-15. Fraction of a Very Large Oil Spill (expressed as a percentage) starting at a given location that will contact a certain environmental resource area within 60 days during winter (Chukchi Sea Sale 193, Table A.2-52).

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
—	LAND	2	1	-	6	4	1	1	2	10	18	10	8	6
1	Kasegaluk Lagoon	-	-	-	1	2	1	-	-	-	5	4	1	-
4	ERA 4	-	-	-	-	-	-	-	-	5	-	-	-	-

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
6	ERA 6	-	1	1	1	2	2	1	3	-	1	5	11	8
10	Ledyard Bay Spectacled Eider Critical Habitat	-	-	-	2	3	1	-	-	2	11	6	1	-
11	Wrangel Island	3	1	-	1	1	-	-	-	-	-	-	-	-
14	Cape Thompson Seabird Colony Area	-	-	-	-	-	-	-	-	2	1	-	-	-
15	Cape Lisburne Seabird Colony Area	-	-	-	-	1	-	-	-	3	4	1	-	-
16	ERA 16	-	-	-	-	-	-	-	-	3	-	-	-	-
19	Chukchi Spring Lead 1	-	-	-	-	-	-	-	-	1	1	-	-	-
20	Chukchi Spring Lead 2	-	-	-	-	1	-	-	-	1	7	2	1	-
21	Chukchi Spring Lead 3	-	-	-	2	2	-	-	-	1	8	5	1	-
22	Chukchi Spring Lead 4	-	-	-	2	3	1	-	-	-	4	9	10	-
23	Chukchi Spring Lead 5	-	-	-	-	-	-	1	-	-	-	1	3	3
24	Beaufort Spring Lead 6	-	-	-	-	-	-	-	2	-	-	-	-	2
25	Beaufort Spring Lead 7	-	-	-	-	-	-	-	2	-	-	-	-	2
26	Beaufort Spring Lead 8	-	-	-	-	-	-	-	1	-	-	-	-	-
38	Pt Hope Subsistence Area	-	-	-	-	-	-	-	-	2	1	-	-	-
39	Point Lay Subsistence Area	-	-	-	3	4	1	-	-	1	20	9	1	-
40	Wainwright Subsistence Area	-	-	-	3	4	1	-	-	-	11	11	14	1
41	Barrow Subsistence Area 1	-	-	-	-	-	-	-	1	-	-	-	1	5
45	ERA 45	-	-	-	-	-	-	-	-	7	2	1	-	-
46	Herald Shoal Polynya	8	1	-	18	1	-	-	-	4	2	-	-	-
47	Ice/Sea Segment 10	6	3	1	17	25	4	1	-	1	10	7	2	-
48	Ice/Sea Segment 11	7	13	12	10	31	49	16	5	2	22	44	22	11
49	Hanna's Shoal Polynya	10	26	64	6	21	43	45	25	1	11	22	19	25
50	Ice/Sea Segment 12	1	3	2	1	5	8	6	2	-	4	14	40	13
51	Ice/Sea Segment 13	-	1	1	-	1	2	2	2	-	1	4	29	18
52	Ice/Sea Segment 14	-	-	-	-	-	-	1	17	-	-	-	3	29
53	Ice/Sea Segment 15	-	-	-	-	-	-	-	2	-	-	-	-	1
59	ERA 59	-	-	-	1	-	-	-	-	2	-	-	-	-
61	ERA 61	-	-	-	-	-	-	-	-	3	-	-	-	-
64	Peard Bay	-	-	-	-	-	1	1	1	-	-	1	1	2
70	ERA 70	-	1	1	-	-	1	1	-	-	-	-	-	-
99	ERA 99	2	1	-	7	13	4	1	-	1	15	19	5	1

Notes: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area. Rows with all values less than 0.5 percent are not shown.

Table B-16. Fraction of a Very Large Oil Spill (expressed as a percentage) starting at a given location that will contact a certain environmental resource area within 360 days during winter (Chukchi Sea Sale 193, Table A.2-54).

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13	P 1
—	LAND	9	7	6	21	16	9	9	13	36	35	24	26	20	43
1	Kasegaluk Lagoon	-	-	-	5	6	1	-	-	1	11	8	3	-	1
2	Point Barrow, Plover Islands	2	3	4	1	2	3	4	6	-	1	2	3	5	-
4	ERA 4	-	-	-	-	-	-	-	-	5	-	-	-	-	9
6	ERA 6	1	2	2	4	8	5	6	9	1	7	13	23	17	1
10	Ledyard Bay Spectacled Eider Critical Habitat	-	-	-	5	7	1	-	-	3	16	10	2	-	2
11	Wrangel Island	4	2	-	1	1	-	-	-	-	-	-	-	-	-
14	Cape Thompson Seabird Colony Area	-	-	-	-	-	-	-	-	2	1	-	-	-	11
15	Cape Lisburne Seabird Colony Area	-	-	-	1	1	-	-	-	4	5	1	1	-	12

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13	P 1
16	ERA 16	-	-	-	2	-	-	-	-	12	2	-	-	-	12
18	ERA 18	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	Chukchi Spring Lead 1	-	-	-	-	-	-	-	-	2	1	-	-	-	13
20	Chukchi Spring Lead 2	-	-	-	1	1	-	-	-	1	8	3	1	-	1
21	Chukchi Spring Lead 3	-	-	-	3	4	1	-	-	1	10	7	1	-	1
22	Chukchi Spring Lead 4	1	-	-	4	6	2	-	-	1	7	12	14	1	1
23	Chukchi Spring Lead 5	-	-	-	-	-	1	1	1	-	-	2	6	5	-
24	Beaufort Spring Lead 6	-	-	-	-	-	-	1	4	-	-	-	2	5	-
25	Beaufort Spring Lead 7	-	1	1	-	-	1	1	4	-	-	-	2	5	-
26	Beaufort Spring Lead 8	-	-	-	-	-	-	-	1	-	-	-	-	1	-
27	Beaufort Spring Lead 9	-	-	-	-	-	-	-	1	-	-	-	-	1	-
28	Beaufort Spring Lead 10	-	-	-	-	-	-	-	1	-	-	-	-	-	-
29	Ice/Sea Segment 1	-	-	-	-	-	1	1	1	-	-	-	-	-	-
30	Ice/Sea Segment 2	-	1	1	-	-	1	1	1	-	-	-	-	1	-
31	Ice/Sea Segment 3	-	1	1	-	-	1	1	1	-	-	-	-	1	-
32	Ice/Sea Segment 4	-	-	1	-	-	1	-	-	-	-	-	-	-	-
35	ERA 35	2	4	4	1	5	6	5	5	-	2	5	7	6	-
36	ERA 36	1	2	1	2	3	2	1	-	-	2	3	3	1	-
38	Pt. Hope Subsistence Area	-	-	-	-	-	-	-	-	2	1	-	-	-	14
39	Point Lay Subsistence Area	1	-	-	6	7	1	-	-	2	25	13	3	-	1
40	Wainwright Subsistence Area	1	1	1	7	10	3	1	1	1	18	19	20	3	1
41	Barrow Subsistence Area 1	-	-	-	-	-	-	1	2	-	-	1	3	6	-
42	Barrow Subsistence Area 2	2	3	3	1	3	3	3	3	-	1	2	3	3	-
45	ERA 45	-	-	-	-	1	-	-	-	7	3	1	1	-	19
46	Herald Shoal Polynya	8	1	-	19	2	-	-	-	4	2	1	-	-	2
47	Ice/Sea Segment 10	7	4	2	19	28	6	1	-	2	13	11	5	1	1
48	Ice/Sea Segment 11	11	20	18	13	37	54	24	14	3	28	50	35	23	2
49	Hanna's Shoal Polynya	15	33	68	10	29	51	54	38	2	19	33	33	38	1
50	Ice/Sea Segment 12	4	6	5	3	11	12	10	4	1	8	20	46	17	1
51	Ice/Sea Segment 13	2	2	2	2	6	5	5	5	-	4	10	37	22	-
52	Ice/Sea Segment 14	2	4	5	1	3	5	6	21	-	2	3	7	32	-
53	Ice/Sea Segment 15	-	1	2	-	1	2	2	4	-	1	1	1	3	-
54	Ice/Sea Segment 16a	-	1	2	-	1	1	1	2	-	-	-	-	1	-
55	Ice/Sea Segment 17	-	1	1	-	-	1	-	-	-	-	-	-	-	-
56	ERA 56	4	8	10	2	6	9	11	9	-	3	5	8	10	-
58	Ice/Sea Segment 20a	-	-	-	-	-	-	1	1	-	-	-	-	1	-
59	ERA 59	-	-	-	2	-	-	-	-	3	1	-	-	-	2
61	ERA 61	-	-	-	-	-	-	-	-	4	-	-	-	-	7
63	ERA 63	1	2	1	-	1	1	1	1	-	-	1	1	1	-
64	ERA 64	1	1	2	1	3	3	4	4	-	2	4	8	7	-
66	ERA 66	1	2	2	1	1	1	1	2	-	1	1	1	2	-
69	ERA 69	-	-	-	-	-	-	-	1	-	-	-	-	-	-
70	ERA 70	1	2	2	-	2	3	3	2	-	1	3	2	3	-
99	ERA 99	4	5	3	11	20	10	4	2	2	21	27	14	4	2

Notes: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area. Rows with all values less than 0.5 percent are not shown.

Table B-17. Fraction of a Very Large Oil Spill (expressed as a percentage) starting at a given location that will contact a certain land segment within 60 days during winter (Chukchi Sea Sale 193, Table A.2-58).

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
8	E. Wrangel Island, Skeletov	1	-	-	-	-	-	-	-	-	-	-	-	-
27	Laguna Nut, Rigol'	-	-	-	1	-	-	-	-	1	-	-	-	-
30	Nutepynmin, Pyngopil'gyn	-	-	-	-	-	-	-	-	1	-	-	-	-
32	Mys Dzhenretlen, Eynenekvyk	-	-	-	-	-	-	-	-	1	-	-	-	-
33	Neskan, Laguna Neskan	-	-	-	-	-	-	-	-	-	-	-	-	-

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
34	Tepken, Memino	-	-	-	-	-	-	-	-	1	-	-	-	-
35	Enurmino, Mys Neten	-	-	-	-	-	-	-	-	2	-	-	-	-
36	Mys Serdtse-Kamen	-	-	-	-	-	-	-	-	1	-	-	-	-
37	Chegitun, Utkan	-	-	-	-	-	-	-	-	1	-	-	-	-
38	Enmytagyn, Inchoun, Mitkulen	-	-	-	-	-	-	-	-	-	-	-	-	-
39	Cape Dezhnev, Naukan, Uelen	-	-	-	-	-	-	-	-	-	-	-	-	-
64	Kukpuk River, Point Hope	-	-	-	-	-	-	-	-	-	-	-	-	-
65	Buckland, Cape Lisburne	-	-	-	-	-	-	-	-	1	-	-	-	-
70	Kuchaurak and Kuchiak Creek	-	-	-	-	-	-	-	-	-	1	-	-	-
71	Kukpowruk River, Sitkok Point	-	-	-	-	-	-	-	-	-	2	-	-	-
72	Point Lay, Siksrikpak Point	-	-	-	-	-	-	-	-	-	3	1	-	-
73	Tungaich Point, Tungak Creek	-	-	-	-	1	-	-	-	-	4	1	-	-
74	Kasegaluk Lagoon, Solivik Isl.	-	-	-	1	1	-	-	-	-	3	2	-	-
75	Akeonik, Icy Cape	-	-	-	1	1	-	-	-	-	2	2	-	-
76	Avak Inlet, Tunalik River	-	-	-	-	-	-	-	-	-	-	-	-	-
78	Point Collie, Sigeakruk Point	-	-	-	-	-	-	-	-	-	-	-	1	-
79	Point Belcher, Wainwright	-	-	-	-	-	-	-	-	-	-	1	2	-
80	Eluksingiak Point, Kugrua Bay	-	-	-	-	-	-	-	-	-	-	1	2	-
81	Peard Bay, Point Franklin	-	-	-	-	-	-	-	-	-	-	-	-	-
82	Skull Cliff	-	-	-	-	-	-	-	-	-	-	-	-	-
83	Nulavik, Loran Radio Station	-	-	-	-	-	-	-	-	-	-	-	-	-
84	Will Rogers & Wiley Post Mem.	-	-	-	-	-	-	-	-	-	-	-	1	2
85	Barrow, Browerville, Elson Lag.	-	-	-	-	-	-	-	1	-	-	-	-	3

Notes: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area. Rows with all values less than 0.5 percent are not shown.

Table B-18. Fraction of a Very Large Oil Spill (expressed as a percentage) starting at a given location that will contact a certain land segment within 360 days during winter (Chukchi Sea Sale 193, Table A.2-60).

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
7	E. Wrangel Island	1	-	-	-	-	-	-	-	-	-	-	-	-
8	E. Wrangel Island, Skeletov	1	1	-	-	-	-	-	-	-	-	-	-	-
24		-	-	-	-	-	-	-	-	-	-	-	-	-
25	Ostrov Leny, Yulinu	-	-	-	1	-	-	-	-	-	-	-	-	-
26	Ekugvaam, Kepin, Pil'khin	-	-	-	1	-	-	-	-	-	-	-	-	-
27	Laguna Nut, Rigol'	1	-	-	1	-	-	-	-	1	-	-	-	-
28	Vankarem,Vankarem Laguna	-	-	-	1	-	-	-	-	1	-	-	-	-
29	Mys Onman, Vel'may	-	-	-	1	-	-	-	-	1	-	-	-	-
30	Nutepynmin, Pyngopil'gyn	-	-	-	2	-	-	-	-	2	-	-	-	-
31	Alyatki, Zaliv Tasytkhin	-	-	-	1	-	-	-	-	2	-	-	-	-
32	Mys Dzhenretlen, Eynenekvyk	-	-	-	1	-	-	-	-	3	-	-	-	-
33	Neskan, Laguna Neskan	-	-	-	1	-	-	-	-	3	-	-	-	-
34	Tepken, Memino	-	-	-	-	-	-	-	-	4	1	-	-	-
35	Enurmino, Mys Neten	-	-	-	1	-	-	-	-	5	1	-	-	-
36	Mys Serdtse-Kamen	-	-	-	-	-	-	-	-	4	-	-	-	-
37	Chegitun, Utkan	-	-	-	-	-	-	-	-	3	-	-	-	-

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
38	Enmytagyn, Inchoun, Mitkulen	-	-	-	-	-	-	-	-	2	-	-	-	-
39	Cape Dezhnev, Naukan, Uelen	-	-	-	-	-	-	-	-	1	-	-	-	-
64	Kukpuk River, Point Hope	-	-	-	-	-	-	-	-	1	-	-	-	-
65	Buckland, Cape Lisburne	-	-	-	-	-	-	-	-	1	-	-	-	-
67	Cape Sabine, Pitmegea River	-	-	-	-	-	-	-	-	-	-	-	-	-
70	Kuchaurak and Kuchiak Creek	-	-	-	-	-	-	-	-	-	1	-	-	-
71	Kukpowruk River, Sitkok Point	-	-	-	-	-	-	-	-	-	3	1	-	-
72	Point Lay, Siksrikpak Point	-	-	-	1	1	-	-	-	-	4	1	-	-
73	Tungaich Point, Tungak Creek	-	-	-	1	1	-	-	-	1	5	2	-	-
74	Kasegaluk Lagoon, Solivik Isl.	-	-	-	2	2	-	-	-	-	4	3	1	-
75	Akeonik, Icy Cape	-	-	-	2	2	-	-	-	-	3	3	1	-
76	Avak Inlet, Tunalik River	-	-	-	-	1	-	-	-	-	1	1	-	-
77	Nivat Point, Nokotlek Point	-	-	-	-	-	-	-	-	-	-	-	-	-
78	Point Collie, Sigeakruk Point	-	-	-	1	1	-	-	-	-	2	2	3	-
79	Point Belcher, Wainwright	-	-	-	-	1	-	-	-	-	1	2	3	-
80	Eluksingiak Point, Kugrua Bay	-	-	-	-	1	-	-	-	-	1	1	4	1
81	Peard Bay, Point Franklin	-	-	-	-	1	1	-	-	-	1	1	1	-
82	Skull Cliff	-	-	-	-	-	1	1	-	-	-	1	2	1
83	Nulavik, Loran Radio Station	-	-	-	-	1	1	1	1	-	-	1	2	2
84	Will Rogers & Wiley Post Mem.	-	-	-	-	-	-	1	1	-	-	-	2	3
85	Barrow, Browerville, Elson Lag.	-	-	-	-	-	-	2	5	-	-	1	4	7
86	Dease Inlet, Plover Islands	-	-	-	-	-	-	1	1	-	-	-	1	1
87	Igalik & Kulgurak Island	2	2	2	1	1	2	1	1	-	1	1	1	1
88	Cape Simpson, Piasuk River	1	1	1	-	1	1	-	1	-	-	-	-	-

Notes: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area. Rows with all values less than 0.5 percent are not shown.

Table B-19. Fraction of a Very Large Oil Spill (expressed as a percentage) starting at a given location that will contact a certain grouped land segment within 60 days during winter (Chukchi Sea Sale 193, Table A.2-64).

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
84	Wrangel Is Nat Res Natural World Heritage Site	1	-	-	-	-	-	-	-	-	-	-	-	-
88	Alaska Maritime National Wildlife Refuge	-	-	-	-	-	-	-	-	1	-	-	-	-
89	National Petroleum Reserve Alaska	-	-	-	-	1	1	-	-	-	1	2	3	1
90	Kasegaluk Lagoon Special Use Area	-	-	-	-	-	-	-	-	-	1	1	-	-
95	Russia Chukchi Coast	2	1	-	3	-	-	-	-	8	1	-	-	-
96	United States Chukchi Coast	-	-	-	3	4	1	-	1	2	17	9	7	3
97	United States Beaufort Coast	-	-	-	-	-	-	-	1	-	-	-	-	3

Notes: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area. Rows with all values less than 0.5 percent are not shown.

Table B-20. Fraction of a Very Large Oil Spill (expressed as a percentage) starting at a given location that will contact a certain grouped land segment within 360 days during winter (Chukchi Sea Sale 193, Table A.2-66).

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
84	Wrangel Is Nat Res Nat World Heritage Site	2	1	-	1	1	-	-	1	-	-	-	1	-
88	Alaska Maritime National Wildlife Refuge	-	-	-	-	-	-	-	-	1	-	-	-	-
89	National Petroleum Reserve Alaska	3	4	4	3	7	6	5	5	-	5	9	13	7
90	Kasegaluk Lagoon Special Use Area	-	-	-	1	1	-	-	-	-	1	1	1	-
91	Teshekpuk Lake Special Use Area	-	-	-	-	1	-	-	1	-	-	-	-	1
95	Russia Chukchi Coast	6	2	-	12	2	1	-	1	32	5	1	1	1
96	United States Chukchi Coast	1	1	1	8	12	5	3	3	4	28	21	20	9
97	United States Beaufort Coast	2	3	4	1	3	4	6	9	-	2	3	6	10

Notes: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area. Rows with all values less than 0.5 percent are not shown.

Table B-21. Fraction of a Very Large Oil Spill (expressed as a percentage) starting at a given location that will contact a certain boundary segment within 60 days during winter (Chukchi Sea Sale 193, Table A.2-70).

ID	Boundary Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
2	Bering Strait	-	-	-	-	-	-	-	-	1	-	-	-	-
15	Chukchi Sea	1	1	-	-	-	-	-	-	-	-	-	-	-
16	Chukchi Sea	1	1	-	-	1	1	-	-	-	-	-	-	-
17	Chukchi Sea	1	1	1	-	-	-	-	-	-	-	-	-	-
18	Chukchi Sea	5	9	10	1	5	8	7	4	-	2	5	3	3
19	Chukchi Sea	5	11	12	1	5	9	9	5	-	2	3	3	5
20	Chukchi Sea	2	5	7	-	4	5	6	6	-	1	2	2	3
21	Chukchi Sea	-	1	2	-	1	1	2	2	-	-	-	-	1
22	Chukchi Sea	-	-	1	-	-	1	1	2	-	-	-	-	1
23	Beaufort Sea	-	-	-	-	-	-	1	1	-	-	-	-	1
24	Beaufort Sea	-	-	-	-	-	-	1	1	-	-	-	-	1
25	Beaufort Sea	-	-	-	-	-	-	-	1	-	-	-	-	-
26	Beaufort Sea	-	-	-	-	-	-	-	1	-	-	-	-	-

Notes: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area. Rows with all values less than 0.5 percent are not shown.

Table B-22. Fraction of a Very Large Oil Spill (expressed as a percentage) starting at a given location that will contact a certain boundary segment within 360 days during winter (Chukchi Sea Sale 193, Table A.2-72).

ID	Boundary Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
2	Bering Strait	-	-	-	-	-	-	-	-	1	-	-	-	-
15	Chukchi Sea	2	2	2	-	1	1	1	-	-	-	1	-	1
16	Chukchi Sea	2	3	1	-	2	2	1	-	-	1	1	1	1
17	Chukchi Sea	2	2	2	1	1	1	1	1	-	1	1	1	1
18	Chukchi Sea	7	12	13	2	7	10	9	6	-	5	8	6	6

ID	Boundary Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
19	Chukchi Sea	10	17	18	4	12	16	17	10	-	7	10	10	11
20	Chukchi Sea	5	10	13	1	9	11	12	11	-	4	6	6	8
21	Chukchi Sea	1	2	3	-	2	2	3	4	-	1	2	2	2
22	Chukchi Sea	-	-	1	-	-	1	2	3	-	-	1	1	2
23	Beaufort Sea	1	1	2	1	1	2	3	4	-	1	1	1	3
24	Beaufort Sea	-	1	1	-	1	1	2	3	-	-	1	1	2
25	Beaufort Sea	-	-	-	-	-	-	-	2	-	-	1	-	1
26	Beaufort Sea	-	1	1	-	1	1	1	2	-	-	1	1	1
27	Beaufort Sea	-	-	1	-	-	1	2	2	-	-	-	1	2
28	Beaufort Sea	-	-	-	-	-	-	-	1	-	-	-	-	-
29	Beaufort Sea	-	-	-	-	-	-	-	1	-	-	-	-	-
30	Beaufort Sea	-	-	-	-	-	-	-	1	-	-	-	-	1

Notes: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area. Rows with all values less than 0.5 percent are not shown.

Table B-23. Range of fractions of a Very Large Oil Spill (expressed as percentages) starting from a given location that will contact a portion of Opilio Arctic EFH area within 3, 10, 30, 60, 180 or 360 days during summer.

Days	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
3	_	_	_	_	_	_	_	_	<0.5->99.5	_	_	_	_
10	_	_	_	_	_	_	_	_	<0.5->99.5	<0.5-1	_	_	_
30	_	_	_	<0.5-1	_	_	_	_	<0.5->99.5	<0.5-2	_	_	_
60	_	_	_	<0.5-1	_	_	_	_	<0.5->99.5	<0.5-2	_	_	_
180	_	_	_	<0.5-1	_	_	_	_	<0.5->99.5	<0.5-2	_	_	_
360	_	_	_	<0.5-1	_	_	_	_	<0.5->99.5	<0.5-2	_	_	_

Notes: - = less than 0.5 percent; LA = Launch Area. LA9 overlaps a portion of EFH.

Table B-24. Range of fractions of a Very Large Oil Spill (expressed as percentages) starting from a given location that will contact a portion of Opilio Arctic EFH area within 3, 10, 30, 60, 180 or 360 days during winter.

Days	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
3	_	_	_	_	_	_	_	_	<0.5->99.5	_	_	_	_
10	_	_	_	_	_	_	_	_	<0.5->99.5	_	_	_	_
30	_	_	_	_	_	_	_	_	<0.5->99.5	<0.5-1	_	_	_
60	_	_	_	<0.5-1	_	_	_	_	<0.5->99.5	<0.5-1	_	_	_
180	_	_	_	<0.5-1	_	_	_	_	<0.5->99.5	<0.5-1	_	_	_
360	_	_	_	<0.5-1	_	_	_	_	<0.5->99.5	<0.5-1	_	_	_

Notes: - = less than 0.5 percent; LA = Launch Area. LA9 overlaps a portion of EFH.

Table B-25. Range of fractions of a Very Large Oil Spill (expressed as percentages) starting from a given location that will contact a portion of Safron Cod EFH area within 3, 10, 30, 60, 180 or 360 days during summer.

Days	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
3	–	–	–	–	–	–	–	–	<0.5->99.5	<0.5-1	<0.5-2	<0.5->99.5	<0.5->99.5
10	–	–	–	–	–	–	–	–	<0.5->99.5	<0.5-2	<0.5-3	<0.5->99.5	<0.5->99.5
30	–	–	–	<0.5-1	<0.5-1	<0.5-1	<0.5-1	<0.5-1	<0.5->99.5	<0.5-4	<0.5-7	<0.5->99.5	<0.5->99.5
60	<0.5-1	<0.5-1	<0.5-1	<0.5-2	<0.5-2	<0.5-3	<0.5-3	<0.5-4	<0.5->99.5	<0.5-5	<0.5-9	<0.5->99.5	<0.5->99.5
180	<0.5-1	<0.5-1	<0.5-2	<0.5-2	<0.5-3	<0.5-4	<0.5-5	<0.5-6	<0.5->99.5	<0.5-5	<0.5-9	<0.5->99.5	<0.5->99.5
360	<0.5-1	<0.5-1	<0.5-2	<0.5-2	<0.5-3	<0.5-4	<0.5-8	<0.5-7	<0.5->99.5	<0.5-5	<0.5-9	<0.5->99.5	<0.5->99.5

Notes: - = less than 0.5 percent; LA = Launch Area. LAs 9, 12 and 13 overlaps a portion of EFH.

Table B-26. Range of fractions of a Very Large Oil Spill (expressed as percentages) starting from a given location that will contact a portion of Safron Cod EFH area within 3, 10, 30, 60, 180 or 360 days during winter.

Days	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
3	–	–	–	–	–	–	–	–	<0.5->99.5	<0.5-1	<0.5-1	<0.5->99.5	<0.5->99.5
10	–	–	–	–	–	–	–	–	<0.5->99.5	<0.5-2	<0.5-2	<0.5->99.5	<0.5->99.5
30	–	–	–	<0.5-1	<0.5-1	–	–	<0.5-1	<0.5->99.5	<0.5-4	<0.5-4	<0.5->99.5	<0.5->99.5
60	–	–	<0.5-1	<0.5-2	<0.5-2	<0.5-1	<0.5-1	<0.5-2	<0.5->99.5	<0.5-6	<0.5-6	<0.5->99.5	<0.5->99.5
180	<0.5-1	<0.5-1	<0.5-1	<0.5-3	<0.5-5	<0.5-2	<0.5-2	<0.5-4	<0.5->99.5	<0.5-7	<0.5-8	<0.5->99.5	<0.5->99.5
360	<0.5-1	<0.5-1	<0.5-1	<0.5-3	<0.5-5	<0.5-2	<0.5-2	<0.5-4	<0.5->99.5	<0.5-7	<0.5-8	<0.5->99.5	<0.5->99.5

Notes: - = less than 0.5 percent; LA = Launch Area. LAs 9, 12 and 13 overlaps a portion of EFH.

Table B-27. Fraction of a Very Large Oil Spill (expressed as a percentage) starting at a given location that will contact environmental resource area 74, 83 or 91within 60 days, during summer Chukchi Sea Sale 212/221 (USDOI, MMS, 2008a: Table A.3-4).

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
74	Offshore Herald Island	4	1	1	2	2	2	1	-	-	-	1	2	1
91	Hope Sea Valley	2	-	-	3	1	-	-	-	1	1	1	-	-

Notes: Only results for ERA 74, 83 and 91 from USDOI, MMS (2008) are shown. Rows with all values<0.5 are not shown. - = less than 0.5 percent; LA = Launch Area.

Table B-28. Fraction of a Very Large Oil Spill (expressed as a percentage) starting at a given location that will contact environmental resource area 74, 83 or 91within 360 days, during summer Chukchi Sea Sale 212/221 (USDOI, MMS, 2008a: Table A.3-5).

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	LA 7	LA 8	LA 9	LA 10	LA 11	LA 12	LA 13
74	Offshore Herald Island	4	1	1	2	2	2	1	-	-	-	1	2	1
91	Hope Sea Valley	2	-	-	3	1	-	-	-	1	1	1	-	-

Notes: Only results for ERA 74, 83 and 91 from USDOI, MMS (2008) are shown. Rows with all values<0.5 are not shown. - = less than 0.5 percent; LA = Launch Area.

Table B-29. Land Segments (LS)—indicated by ID number—contacted in Winter and Summer, percentage of trajectory contact range, and summed average length of LS contacted.

3 Days - Summer			
Launch Area	Land Segment IDs	% Traj.	Length In Km
LA01	none	<0.5	0
LA02	none	<0.5	0
LA03	none	<0.5	0
LA04	none	<0.5	0
LA05	none	<0.5	0
LA06	none	<0.5	0
LA07	none	<0.5	0
LA08	none	<0.5	0
LA09	none	<0.5	0
LA10	none	<0.5	0
LA11	none	<0.5	0
LA12	none	<0.5	0
LA13	none	<0.5	0
10 Days - Summer			
Launch Area	Land Segment IDs	% Traj.	Length In Km
LA01	none	<0.5	0
LA02	none	<0.5	0
LA03	none	<0.5	0
LA04	none	<0.5	0
LA05	none	<0.5	0
LA06	none	<0.5	0
LA07	none	<0.5	0
LA08	85	1	80
LA09	64, 65	1-1	160
LA10	71, 72, 73	1-1	240
LA11	73, 74, 75	1-1	240
LA12	79, 80	1-1	160
LA13	83, 84, 85	1-4	240
30 Days - Summer			
Launch Area	Land Segment IDs	% Traj.	Length In Km
LA01	none	<0.5	0
LA02	none	<0.5	0
LA03	none	<0.5	0
LA04	27, 65, 74	1-1	240
LA05	74, 75	1	160
LA06	none	<0.5	0
LA07	84, 85	1-1	160
LA08	84, 85, 86	1-5	240
LA09	27, 33, 34, 35, 36, 37, 38, 39, 64, 65, 66	1-3	880
LA10	64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75	1-2	960
LA11	71, 72,7 3, 74, 75, 76, 77, 78, 79, 80, 81	1-3	880
LA12	75,77, 78, 79, 80, 81,82,83, 84, 85	1-4	800
LA13	79, 80, 81, 82, 83, 84, 85, 86	1-9	640

3 Days - Winter			
Launch Area	Land Segment IDs	% Traj.	Length In Km
LA01	none	<0.5	0
LA02	none	<0.5	0
LA03	none	<0.5	0
LA04	none	<0.5	0
LA05	none	<0.5	0
LA06	none	<0.5	0
LA07	none	<0.5	0
LA08	none	<0.5	0
LA09	none	<0.5	0
LA10	none	<0.5	0
LA11	none	<0.5	0
LA12	none	<0.5	0
LA13	none	<0.5	0
10 Days - Winter			
Launch Area	Land Segment IDs	% Traj.	Length In Km
LA01	none	<0.5	0
LA02	none	<0.5	0
LA03	none	<0.5	0
LA04	none	<0.5	0
LA05	none	<0.5	0
LA06	none	<0.5	0
LA07	none	<0.5	0
LA08	none	<0.5	0
LA09	none	<0.5	0
LA10	72, 73, 74	1-1	240
LA11	74, 75	1-1	160
LA12	none	<0.5	0
LA13	84, 85	1-1	160
30 Days - Winter			
Launch Area	Land Segment IDs	% Traj.	Length In Km
LA01	none	<0.5	0
LA02	none	<0.5	0
LA03	none	<0.5	0
LA04	27	1	80
LA05	none	<0.5	0
LA06	none	<0.5	0
LA07	none	<0.5	0
LA08	85	1	80
LA09	35	1	80
LA10	71, 72, 73, 74, 75	1-3	400
LA11	72, 73, 74, 75	1-1	320
LA12	79, 80	1-1	160
LA13	84, 85	1-2	160

60 Days – Summer			
Launch Area	Land Segment IDs	% Traj.	Length In Km
LA01	none	<0.5	0
LA02	none	<0.5	0
LA03	83	1	80
LA04	27, 65, 74, 75	1-1	320
LA05	73, 74, 75, 77, 78, 79, 81	1-1	560
LA06	79, 80, 81, 83	1-1	320
LA07	79, 83, 84, 85, 86	1-3	400
LA08	79, 80, 83, 84, 85, 86, 87, 88, 89	1-8	720
LA09	27, 32, 33, 34, 35, 36, 37, 38, 39, 64, 65, 66, 67	1-3	1040
LA10	64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 77	1-4	1040
LA11	65, 66, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81	1-4	1040
LA12	74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85	1-6	960
LA13	79, 80, 81, 82, 83, 84, 85, 86, 87	1-11	720

60 Days - Winter			
Launch Area	Land Segment IDs	% Traj.	Length In Km
LA01	8	1	80
LA02	none	<0.5	0
LA03	none	<0.5	0
LA04	27, 74, 75	1-1	240
LA05	73, 74, 75	1-1	240
LA06	none	<0.5	0
LA07	none	<0.5	0
LA08	85	1	80
LA09	27, 30, 32, 34, 35, 36, 37, 65	1-2	640
LA10	70, 71,72, 73, 74, 75	1-4	480
LA11	72, 73, 74, 75, 79, 80	1-2	480
LA12	78, 79, 80, 84	1-2	320
LA13	84, 85	2-3	160

180 Days – Summer			
Launch Area	Land Segment IDs	% Traj.	Length In Km
LA01	None	<0.5	0
LA02	None	<0.5	0
LA03	83, 85	1-1	160
LA04	27, 65, 73, 74, 75	1-1	400
LA05	65, 73, 74, 75, 77, 78, 79, 80, 81, 83	1-1	800
LA06	79, 80, 81, 83, 84	1-1	400
LA07	79, 80, 81, 83, 84, 85, 86,	1-4	560
LA08	79, 80, 83, 84, 85, 86, 87, 88, 89, 91	1-9	800
LA09	27, 30, 32, 33, 34, 35, 36, 37, 38, 39, 64, 65, 66, 67	1-3	1120
LA10	64, 65, 66, 67,68,69,70, 71, 72, 73, 74, 75,77	1-4	1040
LA11	65, 66, 71,72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82	1-4	1120
LA12	74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85	1-6	960
LA13	79, 80, 81, 82, 83, 84, 85, 86, 87	1-12	720

180 Days - Winter			
Launch Area	Land Segment IDs	% Traj.	Length In Km
LA01	7, 8, 27, 87	1-1	320
LA02	8, 87	1-1	160
LA03	87	1	80
LA04	27, 28, 29, 30, 31, 32, 72, 73, 74, 75	1-2	800
LA05	72,73, 74, 75, 76, 78, 79, 80, 81, 83, 87	1-2	880
LA06	81, 82, 83, 87	1-1	320
LA07	82, 83, 84, 85, 86, 87	1-2	480
LA08	83, 84, 85, 86, 87	1-5	400
LA09	27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 64, 65, 73	1-5	1280
LA10	35, 70, 71, 72, 73, 74, 75, 76, 78, 79, 80, 81	1-5	960
LA11	71, 72, 73, 74, 75, 76, 78, 79, 80, 81, 82, 83	1-3	960
LA12	74, 75, 78, 79, 80, 81, 82, 83, 84, 85, 86	1-4	880
LA13	80, 82, 83, 84, 85, 86	1-7	480

360 Days - Summer			
Launch Area	Land Segment IDs	% Traj.	Length In Km
LA01	None	<0.5	0
LA02	84	1	80
LA03	83, 84, 85	1-2	240
LA04	27, 65, 73, 74, 75	1-1	400
LA05	65, 73, 74, 75,77,78, 79, 80, 81, 83	1-1	800
LA06	79, 80, 81, 83, 84, 85	1-2	480

360 Days - Winter			
Launch Area	Land Segment IDs	% Traj.	Length In Km
LA01	7, 8, 27, 87, 88	1-2	400
LA02	8, 87, 88	1-2	240
LA03	87, 88	1-2	160
LA04	25, 26, 27, 28, 29, 30, 31, 32, 33, 35, 72, 73, 74, 75, 78, 87	1-2	1280
LA05	72, 73, 74, 75, 76, 78, 79, 80, 81, 83, 87, 88	1-2	960
LA06	81, 82, 83, 87, 88	1-2	400

LA07	79, 80, 81, 83, 84, 85, 86	1-5	560
LA08	8, 26, 79, 80, 82, 83, 84, 85, 86, 87, 88, 89, 91	1-10	1040
LA09	27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 64, 65, 66, 67	1-3	1360
LA10	33, 35, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 77	1-4	1200
LA11	65, 66, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 84	1-4	1200
LA12	74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85	1-6	960
LA13	8, 79, 80, 81, 82, 83, 84, 85, 86, 87, 91	1-13	880

LA07	82, 83, 84, 85, 86, 87	1-2	480
LA08	83, 84, 85, 86, 87, 88	1-5	480
LA09	27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 64, 65, 73	1-5	1280
LA10	34, 35, 70, 71, 72, 73, 74, 75, 76, 78,79, 80, 81, 87	1-5	1120
LA11	71,72, 73, 74, 75, 76, 78, 79, 80, 81, 82, 83, 85, 87	1-3	1120
LA12	74, 75, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87	1-4	960
LA13	80, 82, 83, 84, 85, 86, 87	1-7	560

FIGURES

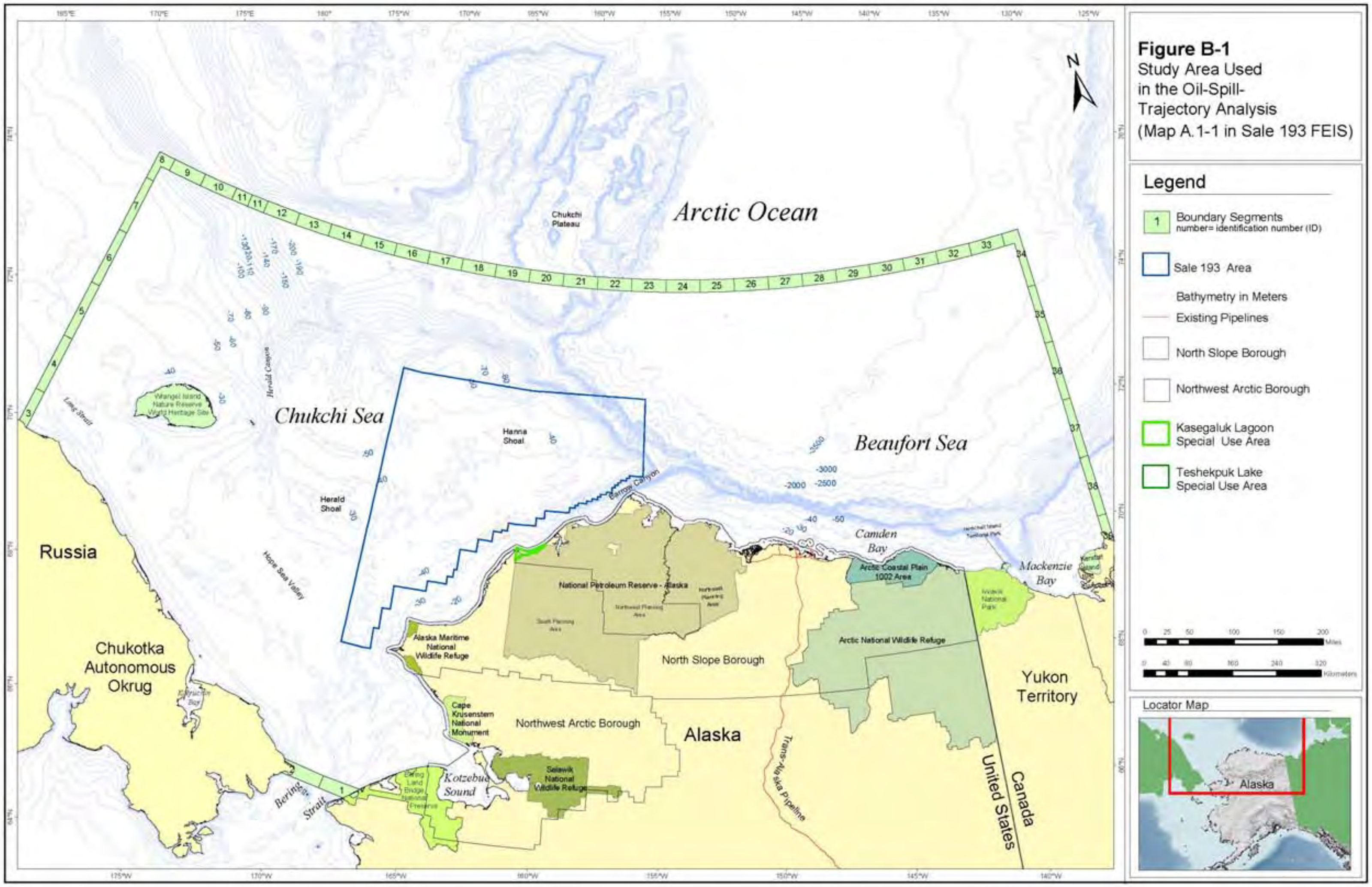

Figure B-1. Study area used in the oil spill trajectory analysis. (Map A.1-1 in Sale 193 FEIS)

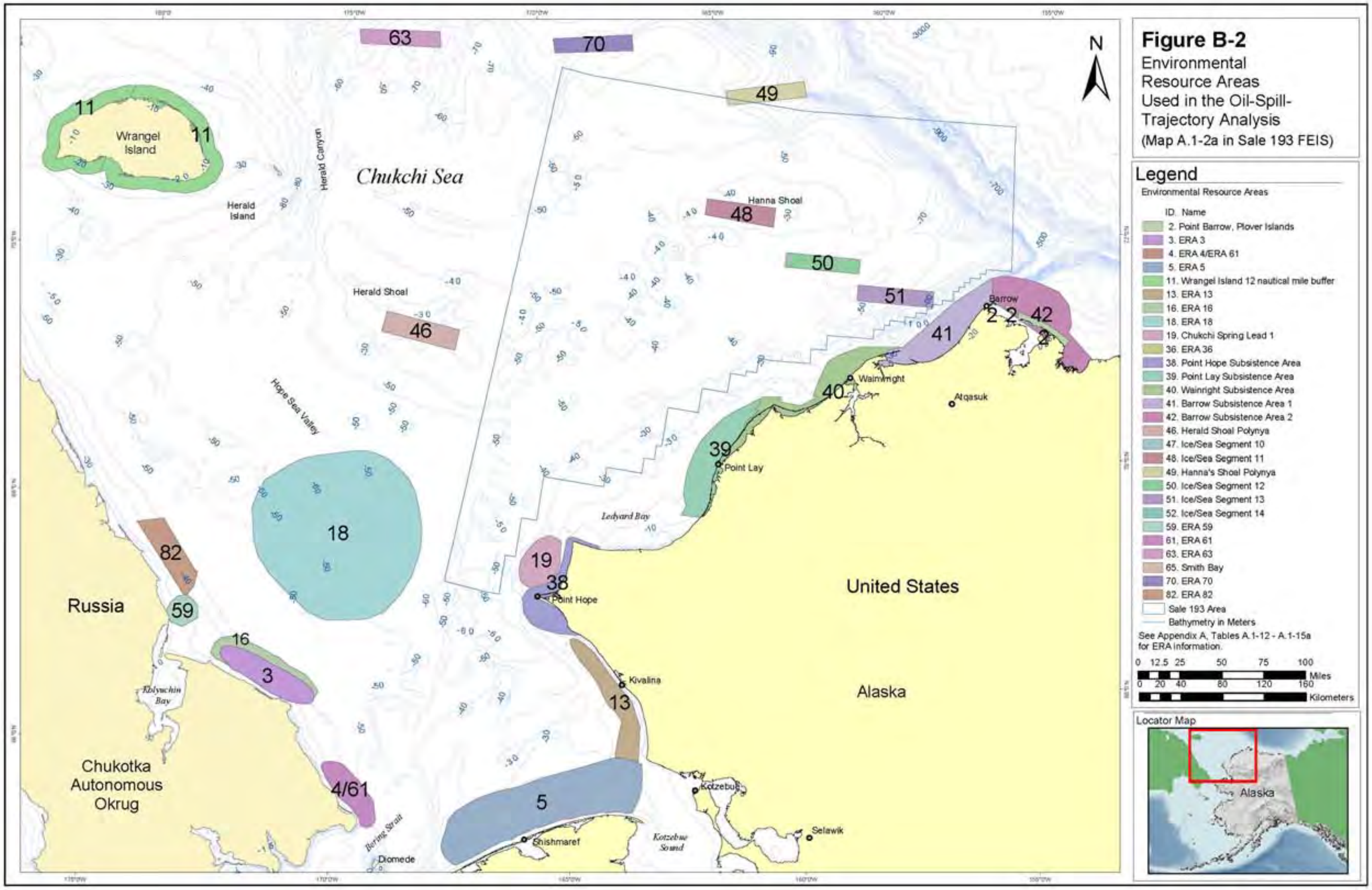

Figure B-2. Environmental Resource Areas used in the oil spill trajectory analysis. (Map A.1-2a in Sale 193 FEIS)

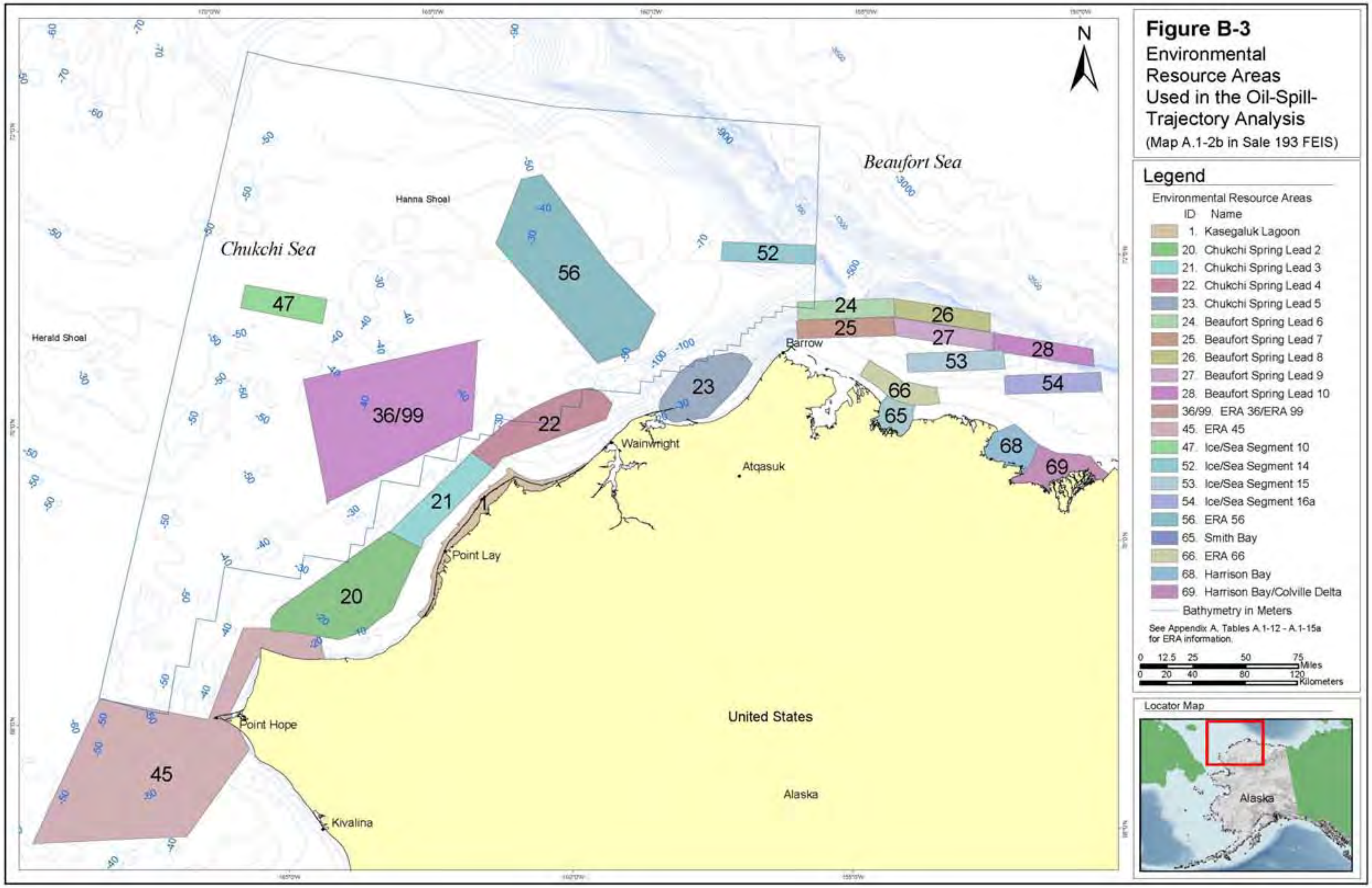

Figure B-3. Environmental Resource Areas used in the oil spill trajectory analysis. (Map A.1-2b in Sale 193 FEIS)

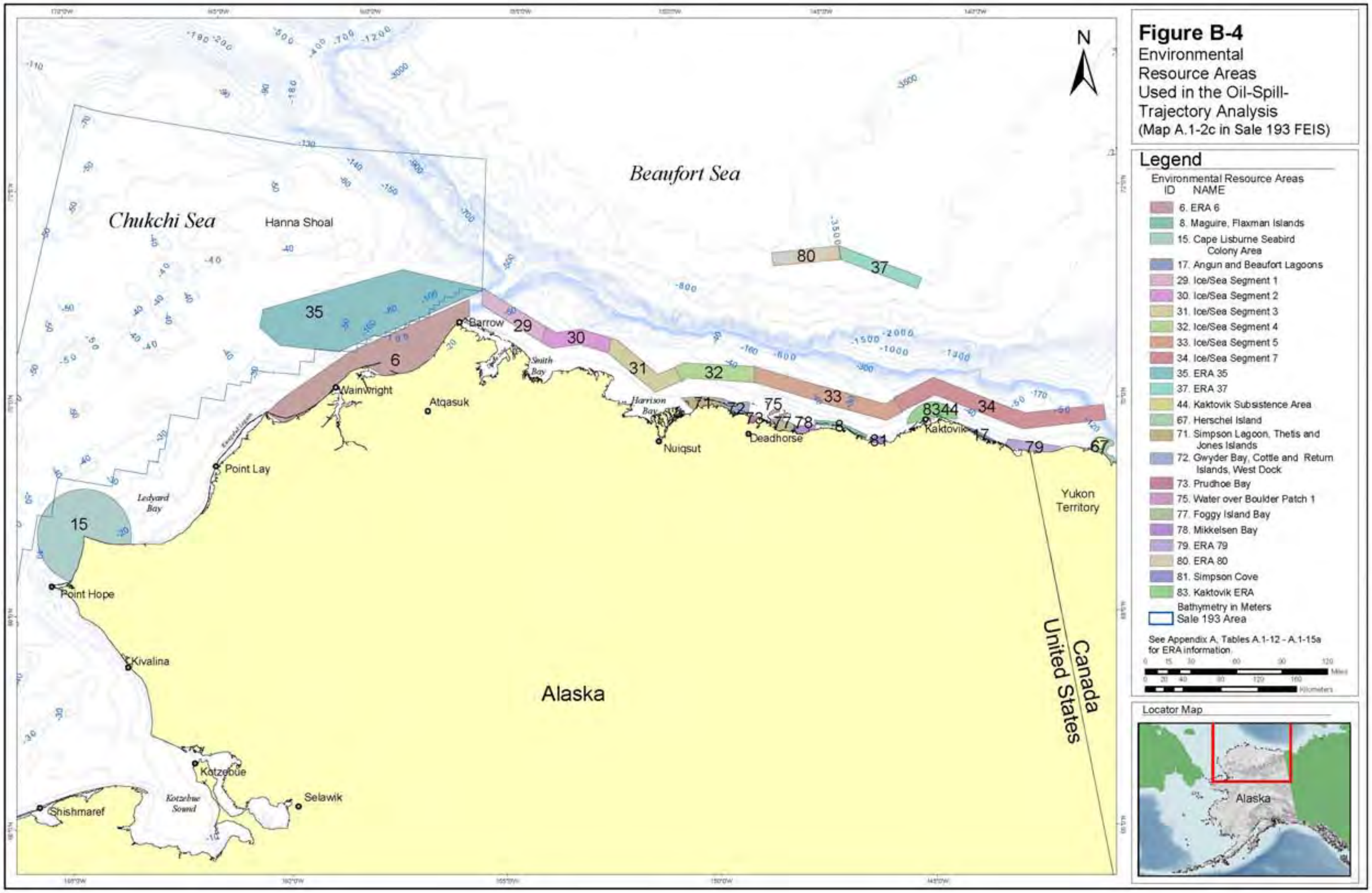

Figure B-4. Environmental Resource Areas used in the oil spill trajectory analysis. (A.1-2c in Sale 193 FEIS).

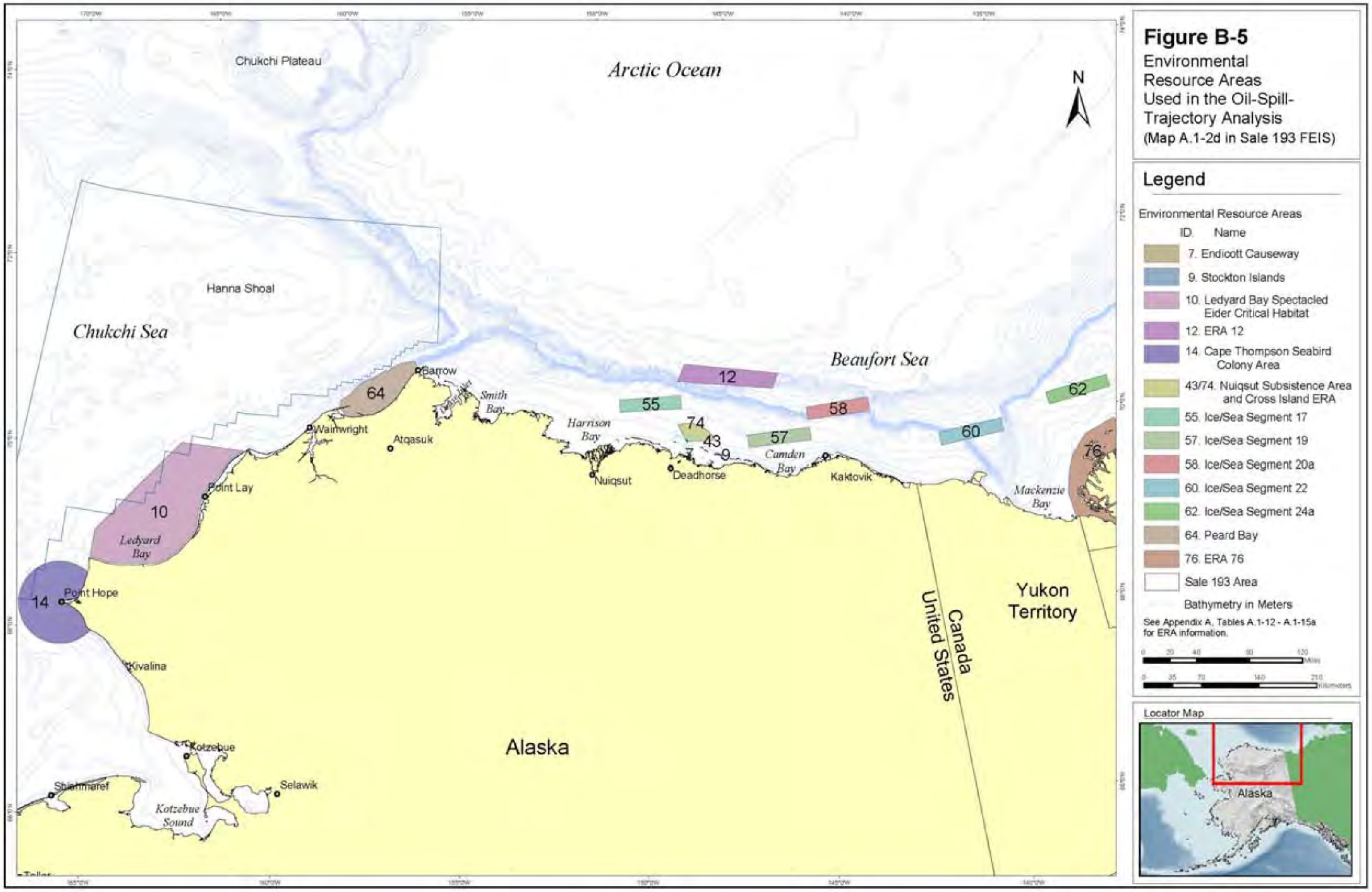

Figure B-5. Environmental Resource Areas used in the oil spill trajectory analysis. (A.1-2d in Sale 193 FEIS).

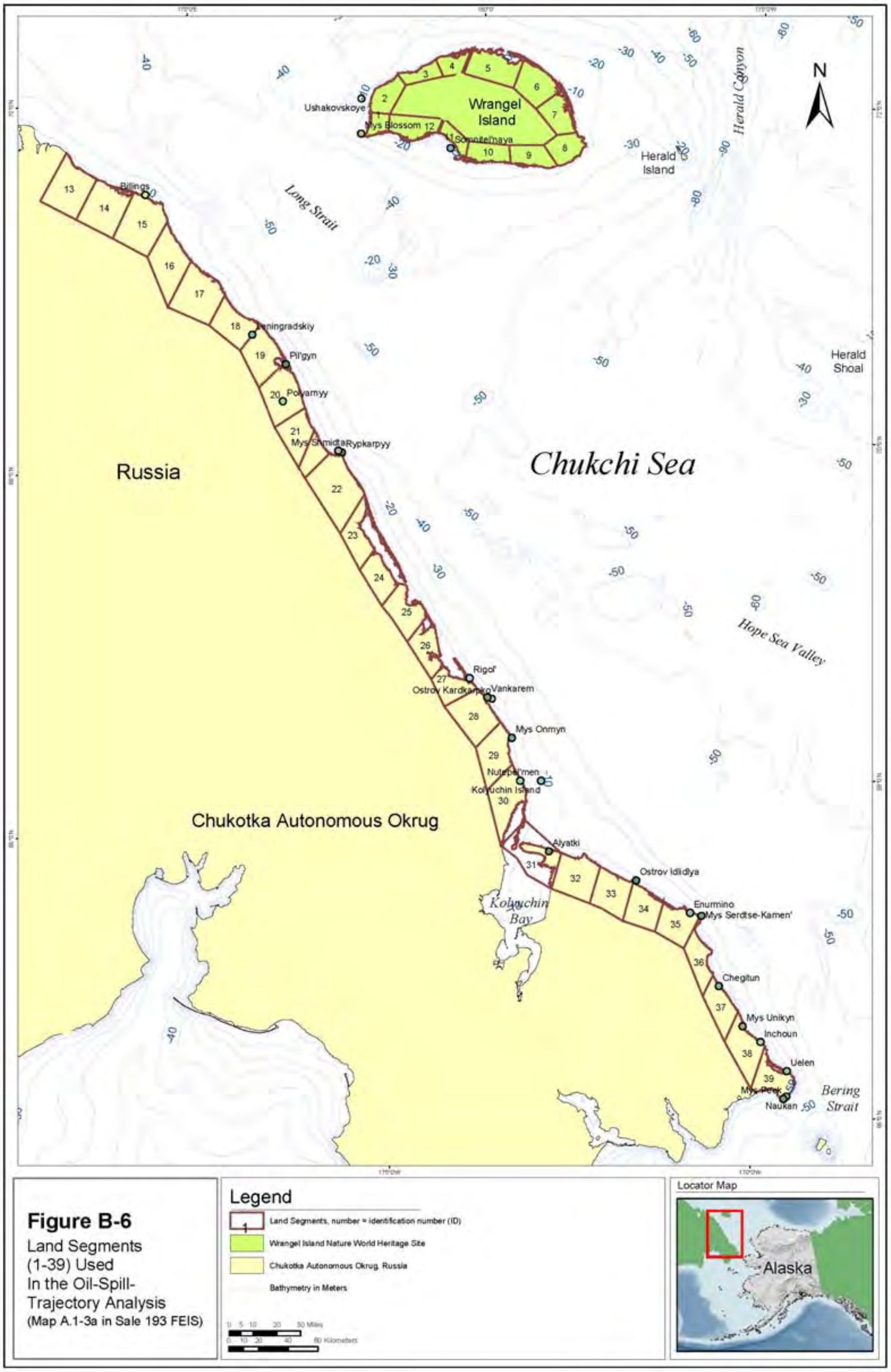

Figure B-6. Land Segments (1–39) used in the oil spill trajectory analysis. (Map A.1-3a in Sale 193 FEIS)

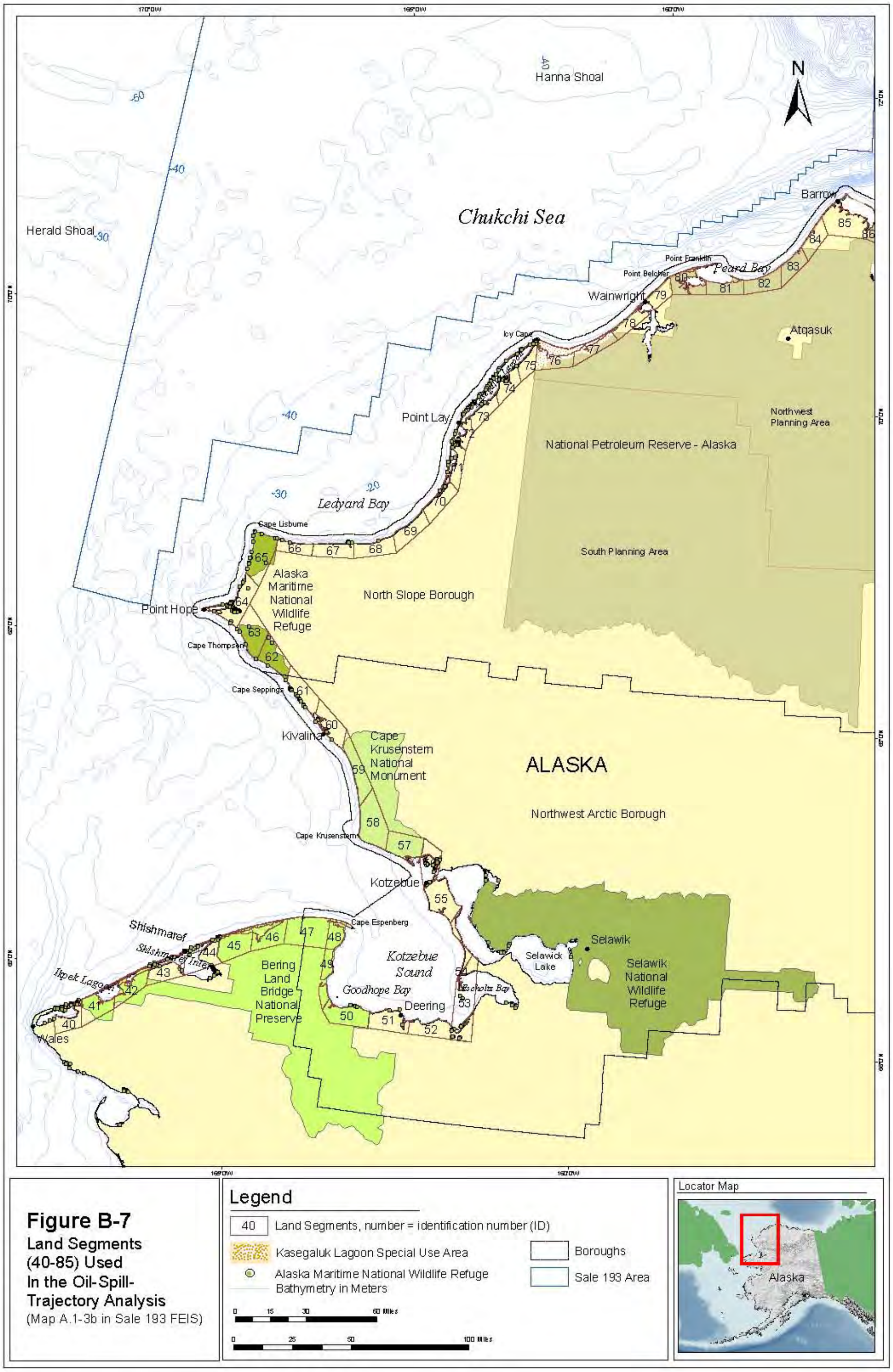

Figure B-7. Land Segments (40–85) used in the oil spill trajectory analysis. (Map A.1-3b in Sale 193 FEIS)

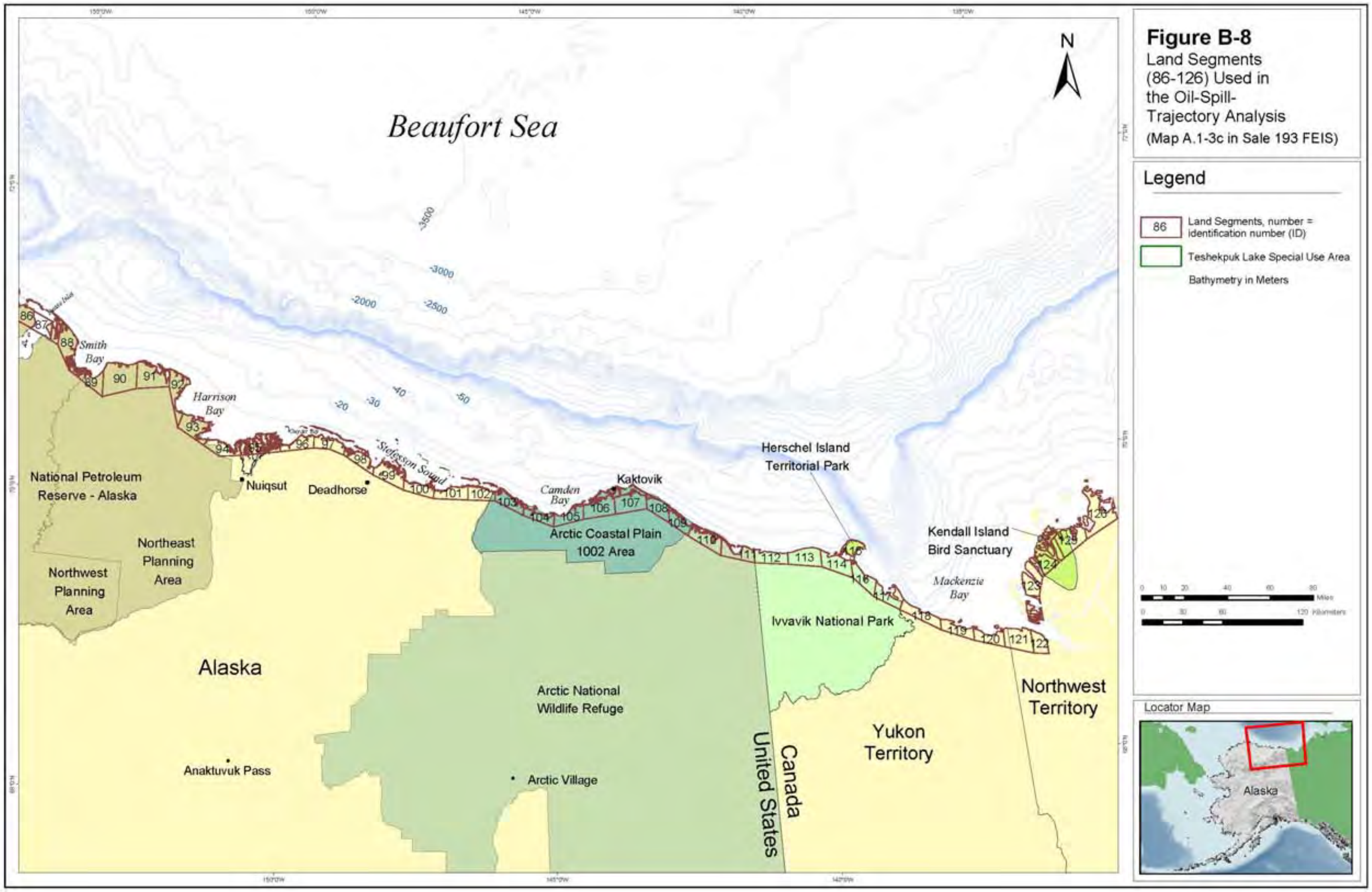

Figure B-8. Land Segments (86–126) used in the oil spill trajectory analysis. (Map A.1-3c in Sale 193 FEIS)

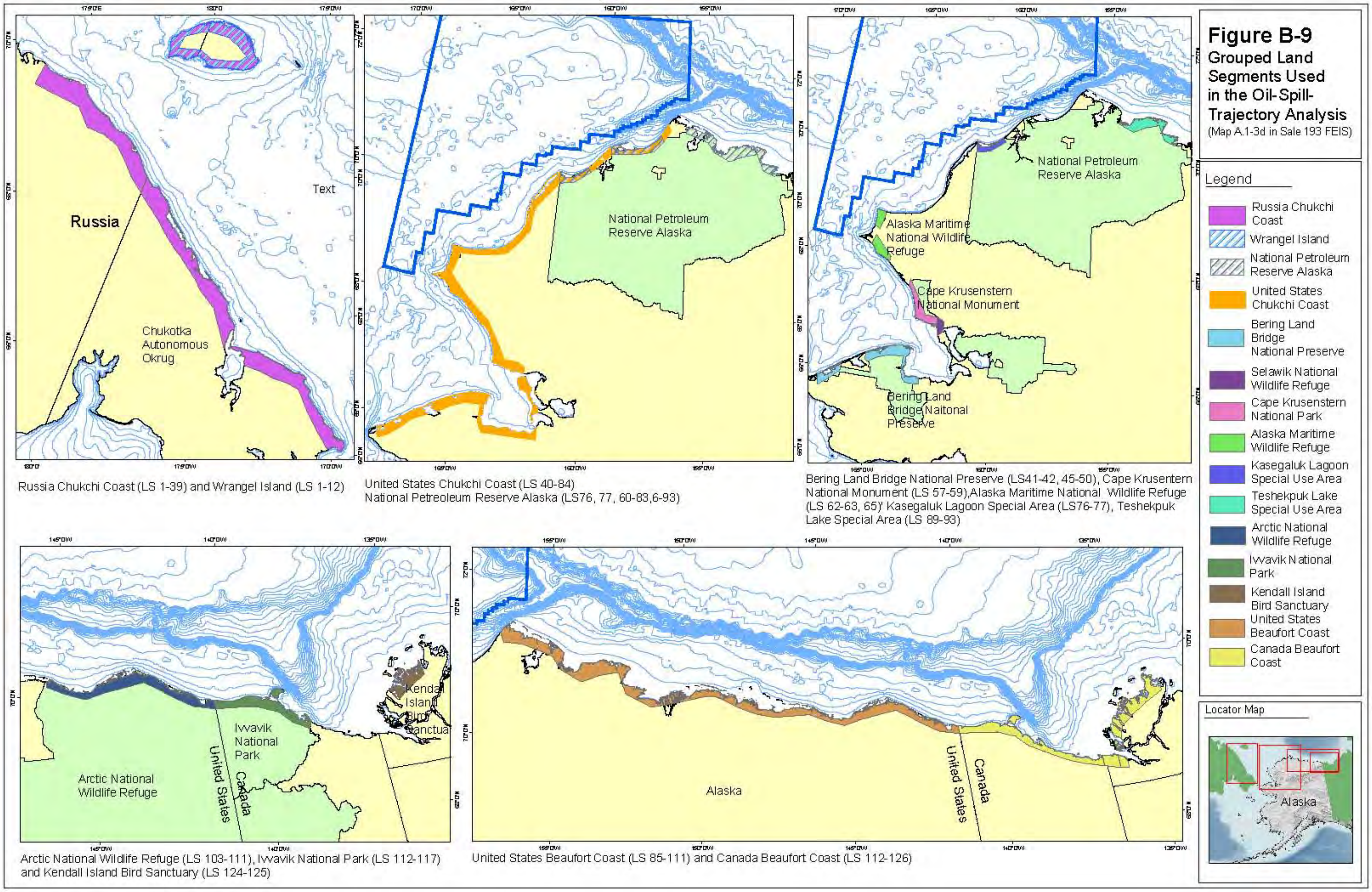

Figure B-9. Grouped Land Segments used in the oil spill trajectory analysis. (Map A.1-3d in Sale 193 FEIS)

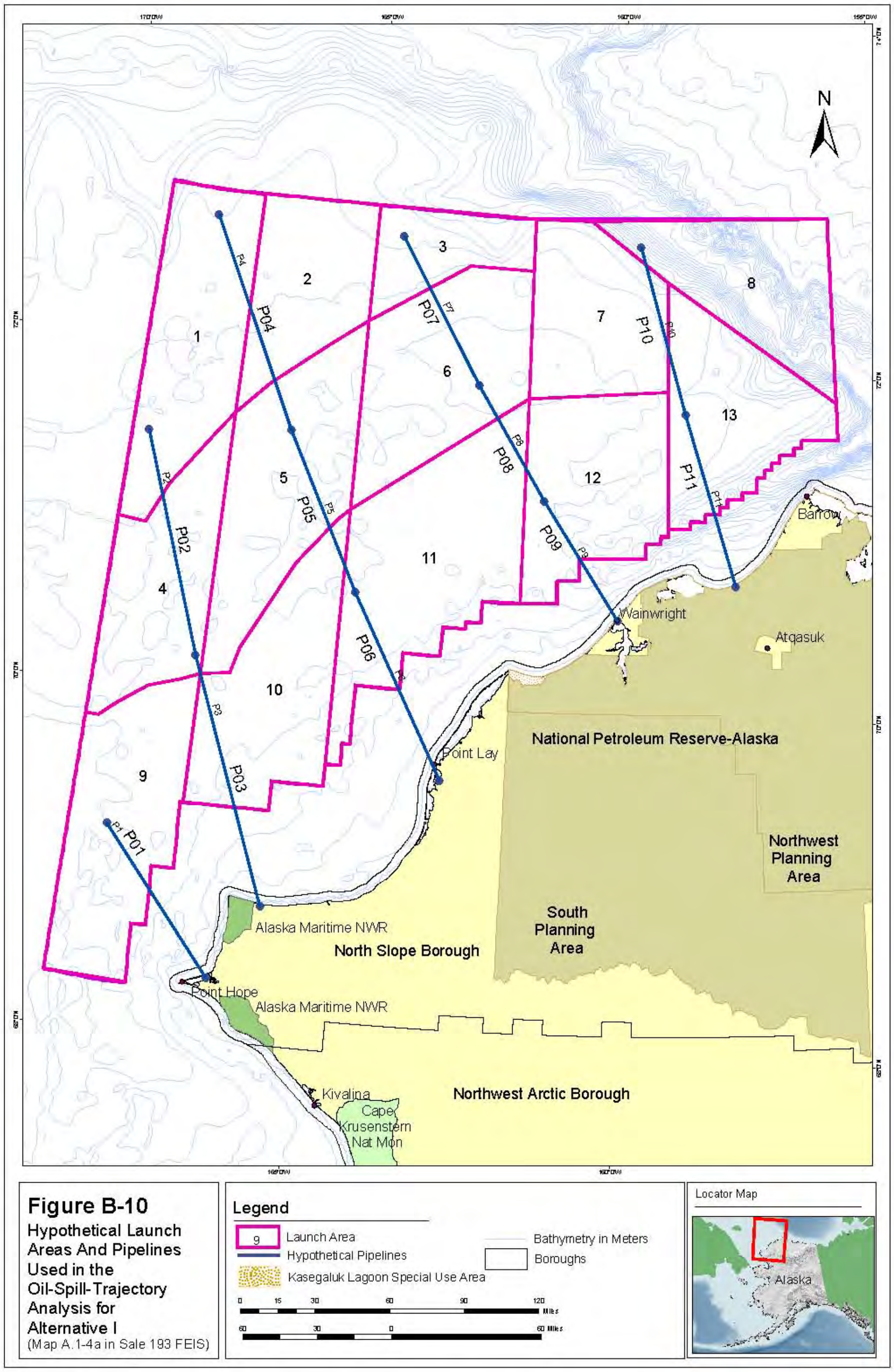

Figure B-10. Hypothetical Launch Areas and pipelines used in the oil spill trajectory analysis for Alternative 1. (Map A.1-4a in Sale 193 FEIS)

Fish Resources and EFH

Summary Table and Figures

Appendix C. Fish Resources and EFH –Tables and Figures

List of Tables

List of Figures

Table C-1. Fish (adult life stage) in coastal and marine waters of the Chukchi Sea: known habitat and behavioral stratification and potential effects from VLOS in the Chukchi Sea.

Family	Fish Species	Fish Common Name	Distribution in Chukchi Sea	Life History	Coastal and Nearshore up to 2 m	Up to 50m depth	50-100m depth	100- 500 m depth	> 500 m depth	Demersal	Pelagic	Phase of Chukchi Sea VLOS (1-5) that Could Affect the Species
Petromyzontidae (lampreys)	*Lampetra tridentata*	Pacific lamprey	Rare	Anadromous	X	X	X	X		X	X	1,2,3,4,5 (rare)
	Lampetra camtschatica	Arctic lamprey	Widespread	Anadromous	X	X	X	X		X	X	1,2,3,4,5
Dalatiidae (sleeper sharks)	*Somniosus pacificus*	Pacific sleeper shark	Widespread	Marine		X	X	X	X	X	X	1,2,4,5
Lamnidae (mackerel sharks)[1]	*Lamna ditropis*[1]	salmon shark	Rare	Marine	X	X	X	X		X	X	1,2,3,4,5 (rare))
Squalidae (dogfish sharks)	*Squalus acanthias*	spiny dogfish	Rare	Marine		X	X	X	X	X	X	1,2,4,5 (rare)
Rajidae (skates)	*Bathyraja parmifera*	Alaska skate	Rare	Marine	X	X	X			X		1,2,4,5 (rare)
Clupeidae (herrings)	*Clupea pallasii*	Pacific herring	Widespread	Marine		X	X	X		X	X	1,2,4,5 (no known spawning)
Osmeridae (smelts)	*Mallotus villosus*	capelin	Widespread	Marine	X	X	X	X		X	X	1,2,3,4,5
	Osmerus mordax	rainbow smelt	Widespread	Anadromous	X	X	X	X		X	X	1,2,3,4, 5
Salmonidae/Coregoninae (whitefishes)	*Coregonus sardinella*	least cisco	Widespread	Anadromous	X	X	X			X	X	1,2,3,4,5
	Coregonus laurettae	Bering cisco	Widespread	Anadromous	X	X	X			X	X	1,2,3,4,5
	Coregonus nasus	broad whitefish	Widespread	Anadromous, Freshwater	X	X				X	X	1,2,3,4,5
	Coregonus pidschian	humpback whitefish	Widespread	Anadromous, Freshwater	X	X				X	X	1,2,3,4,5
Salmonidae/Salmoninae (trouts and salmons)	*Salvelinus alpinus*	Arctic char	Widespread	Anadromous, Freshwater	X	X				X	X	1,2,3,4,5
	Salvelinus malma	Dolly Varden	Widespread	Anadromous	X	X	X	X		X	X	1,2,3,4,5
	Oncorhynchus gorbuscha	pink salmon	Widespread	Anadromous	X	X	X	X		X	X	1,2,3,4,5

Family	Fish Species	Fish Common Name	Distribution in Chukchi Sea	Life History	Coastal and Nearshore up to 2 m	Up to 50m depth	50-100m depth	100- 500 m depth	> 500 m depth	Demersal	Pelagic	Phase of Chukchi Sea VLOS (1-5) that Could Affect the Species
	Oncorhynchus kisutch	coho salmon	Widespread	Anadromous	X	X	X	X		X	X	1,2,3,4,5
	Oncorhynchus tshawytscha	chinook salmon	Widespread	Anadromous	X	X	X	X		X	X	1,2,3,4,5
	Oncorhynchus keta	chum salmon	Widespread	Anadromous	X	X	X	X		X	X	1,2,3,4,5
	Oncorhynchus nerka	sockeye salmon	Widespread	Anadromous	X	X	X	X		X	X	1,2,3,4,5
Gadidae (cods)	*Boreogadus saida*	Arctic cod	Widespread	Marine	X		X	X	X	X	X	1,2,4,5
	Eleginus gracilis	saffron cod	Widespread	Marine	X	X	X	X		X	X	1,2,3,4,5
	Theragra chalcogramma	walleye pollock	Widespread	Marine		X	X	X	X	X	X	1,2,4,5
	Gadus macrocephalus	Pacific cod	Rare	Marine		X	X	X			X	1,2,4,5 (rare)
Gasterosteidae (sticklebacks	*Gasterosteus aculeatus*	threespine stickleback	Rare	Anadromous, Freshwater	X	X				X		1,2,3,4,5 (rare)
	Pungitius pungitius	ninespine stickleback	Widespread	Anadromous, Freshwater	X	X				X		1,2,3,4,5
Hexagrammidae (greenlings)	*Hexagrammos stelleri*	whitespotted greenling	Widespread	Marine		X	X	X		X		1,2,4,5
Cottidae (sculpins)	*Triglops pingelii*	ribbed sculpin	Widespread	Marine		X	X	X		X		1,2,4,5
	Hemilepidotus papilio	butterfly sculpin	Widespread	Marine		X	X	X		X		1,2,4,5
	Hemilepidotus jordani	yellow Irish lord	Rare	Marine		X	X	X		X		1,2,4,5 (rare)
	Icelus spatula	spatulate sculpin	Widespread	Marine		X	X	X		X		1,2,4,5
Cottidae (sculpins)	*Gymnocanthus tricuspis*	Arctic staghorn sculpin	Widespread	Marine		X	X	X		X		1,2,4,5
	Cottus aleuticus	coastrange sculpin	Limited Distribution	Brackish, Freshwater	X	X				X		3,4,5
	Enophrys diceraus	antlered sculpin	Widespread	Marine		X	X	X		X		1,2,4,5
	Megalocottus platycephalus	belligerent sculpin	Widespread	Brackish	X	X				X		3,4,5
	Myoxocephalus	fourhorn sculpin	Widespread	Brackish, Marine,	X	X				X		1,2,3,4,5

Family	Fish Species	Fish Common Name	Distribution in Chukchi Sea	Life History	Coastal and Nearshore up to 2 m	Up to 50m depth	50-100m depth	100- 500 m depth	> 500 m depth	Demersal	Pelagic	Phase of Chukchi Sea VLOS (1-5) that Could Affect the Species
	quadricornis			Freshwater								
	Myoxocephalus scorpius	shorthorn sculpin	Widespread	Brackish, Freshwater	X	X				X		3,4,5
	Myoxocephalus polyacanthocephalus	great sculpin	Widespread	Marine		X	X			X		1,2,4,5
	Myoxocephalus scorpioides	Arctic sculpin	Widespread	Brackish, Freshwater	X	X				X		3,4,5
	Myoxocephalus jaok	plain sculpin	Widespread	Marine		X	X			X		1,2,4,5
	Microcottus sellaris	brightbelly sculpin	Rare	Brackish, Freshwater	X	X				X		3,4,5 (rare)
	Artediellus gomojunovi	spinyhook sculpin	Rare	Marine		X	X			X		1,2, 3, 4,5 (rare)
	Artediellus scaber	hamecon	Widespread	Brackish, Freshwater	X	X				X		3,4,5
	Artediellus pacificus	hookhorn sculpin	Rare	Marine		X	X			X		1,2,3,4,5 (rare)
	Artediellus ochotensis	Okhotsk hookear sculpin	Rare	Marine		X	X			X		1,2,4,5 (rare)
	Gymnocanthus pistilliger	threaded sculpin	Rare	Marine		X	X			X		1,2,4,5 (rare)
	Trichocottus brashnikovi	hairhead Sculpin	Rare	Marine		X	X			X		1,2,4,5 (rare)
Hemitripteridae (sailfin sculpins)	*Blepsias bilobus*	crested sculpin	Widespread	Marine		X	X	X		X		1,2,4,5
	Nautichthys pribilovius	eyeshade sculpin	Widespread	Marine		X	X	X		X		1,2,4,5
Psychrolutidae (fathead sculpins)	*Eurymen gyrinus*	smoothcheek sculpin	Rare	Marine		X	X	X		X		1,2,4,5 (rare)
Agonidae (poachers)	*Hypsagonus quadricornis*	fourhorn poacher	Rare	Marine		X	X	X		X		1,2,4,5 (rare)
	Pallasina barbata	tubenose poacher	Rare	Marine		X	X					1,2,4,5 (rare)
	Occella dodecaedron	Bering poacher	Rare	Marine		X	X			X		1,2,4,5 (rare)
	Leptagonus	Atlantic poacher	Rare	Marine		X	X	X		X		1,2,4,5 (rare)

Family	Fish Species	Fish Common Name	Distribution in Chukchi Sea	Life History	Coastal and Nearshore up to 2 m	Up to 50m depth	50-100m depth	100- 500 m depth	> 500 m depth	Demersal	Pelagic	Phase of Chukchi Sea VLOS (1-5) that Could Affect the Species
	decagonus											
	Podothecus veternus	veteran poacher	Rare and Patchy	Marine		X	X	X		X		1,2,4,5 (rare)
	Aspidophoroides olrikii	Arctic alligatorfish	Widespread	Brackish, Freshwater	X	X				X	X	3,4,5
	Aspidophoroides monopterygius	alligatorfish	Limited Distribution	Marine		X	X			X	X	1,2,4,5
	Eumicrotremus andriashevi	pimpled lumpsucker	Rare	Marine		X	X			X		1,2,4,5 (rare)
Liparidae (snailfishes)	*Liparis gibbus*	variegated snailfish	Widespread	Marine		X	X	X		X		1,2,4,5
	Liparis tunicatus	kelp snailfish	Widespread	Marine		X	X	X		X		1,2,4,5
	Liparis bristolensis	Bristol snailfish	Rare	Marine		X	X			X		1,2,4,5 (rare)
	Liparis callyodon	spotted snailfish	Widespread	Marine		X	X			X		1,2,4,5
	Liparis fabricii	gelatinous snalifish	Rare	Marine		X	X			X		1,2,4,5 (rare)
Zoarcidae (eelpouts)	*Gymnelus hemifasciatus*	halfbarred pout	Rare and Patchy	Marine		X	X			X		1,2,4,5 (rare)
	Gymnelus viridis	fish doctor	Rare and Patchy	Marine		X	X	X		X		1,2,4,5 (rare)
	Lycodes mucosus	saddled eelpout	Rare	Marine			X	X		X		1,2,4,5 (rare)
	Lycodes turneri	estuarine eelpout	Widespread	Marine			X	X		X		1,2,4,5
	Lycodes polaris	polar eelpout	Widespread	Marine			X	X		X		1,2,4,5
	Lycodes raridens	marbled eelpout	Widespread	Marine		X	X	X		X		1,2,4,5
	Lycodes rossi	threespot eelpout	Rare	Marine		X	X	X		X		1,2,4,5 (rare)
	Lycodes palearis	wattled eelpout	Widespread	Marine		X	X	X		X		1,2,4,5
	Lycodes concolor	ebony eelpout	Rare	Marine		X	X	X		X		1,2,4,5 (rare)
	Zaprora silenus	prowfish	Rare	Marine		X	X			X		1,2,4,5 (rare)
Stichaeidae (pricklebacks	*Eumesogrammus praecisus*	fourline snakeblenny	Widespread	Marine		X	X	X		X		1,2,4,5
	Stichaeus punctatus	Arctic shanny	Widespread	Marine		X	X			X		1,2,4,5
	Chirolophis snyderi	bearded warbonnet	Rare	Marine		X	X			X		1,2,4,5 (rare)
	Leptoclinus	daubed shanny	Rare	Marine		X	X			X		1,2,4,5 (rare)

Family	Fish Species	Fish Common Name	Distribution in Chukchi Sea	Life History	Coastal and Nearshore up to 2 m	Up to 50m depth	50-100m depth	100- 500 m depth	> 500 m depth	Demersal	Pelagic	Phase of Chukchi Sea VLOS (1-5) that Could Affect the Species
	maculatus											
	Anisarchus medius	stout eelblenny	Widespread	Marine		X	X			X		1,2,4,5
	Lumpenus fabricii	slender eelblenny	Widespread	Marine		X	X			X		1,2,4,5
Pholidae (gunnels)	*Pholis fasciata*	banded gunnel	Rare	Marine		X	X			X		1,2,4,5 (rare)
Anarhichadidae (wolffishes)	*Anarhichas orientalis*	Bering wolffish	Widespread	Marine		X	X			X		1,2,4,5
	Anarhichas denticulatus[2]	Northern wolfish	Rare	Marine		X	X			X		1,2,4,5 (rare)
Ammodytidae (sand lances)	*Ammodytes hexapterus*	Pacific sand lance	Widespread	Marine	X	X	X			X	X	1,2,4,5, 5
Pleuronectidae (righteye flounders)	*Hippoglossus stenolepis*	Pacific halibut	Unverified, Rare, Disjunct	Marine		X	X	X	X	X		1,2,4,5 (rare)
	Hippoglossoides robustus	Bering flounder	Widespread	Marine		X	X	X		X		1,2,4,5
	Reinhardtius hippoglossoides	Greenland halibut	Unverified, Patchy	Marine		X	X	X	X	X		1,2,4,5
	Platichthys stellatus	starry flounder	Widespread	Marine, Brackish	X	X	X	X		X		1,2,3,4,5
	Pleuronectes quadrituberculatus	Alaska plaice	Widespread	Marine		X	X	X		X		1,2,3,4,5
	Pleuronectes glacialis	Arctic flounder	Widespread	Marine, Brackish	X	X	X			X		1,2,3,4,5
	Limanda proboscidea	longhead dab	Widespread	Marine		X				X		1,2,4,5
	Limanda aspera	yellowfin sole	Widespread	Marine		X	X	X	X	X		1,2,4,5
	Limanda sakhalinensis	Sakhalin sole	Unverified, Rare, Disjunct	Marine		X	X	X		X		1,2,4,5 (rare)

Sources: Mecklenburg, Moller and Steinke, 2011; Mecklenburg, et al., 2007; Norcross, et al. 2010; Hopcroft, et al., 2006; Fautin, et al., 2010; Froese and Pauly, 2003; Mecklenburg, Mecklenburg, and Thorsteinson, et al., 2002; Moulton and George, 2000; Stevenson,et al., 2004; Barber, et al., 1994,1997; Craig, 1989; Frost and Lowry. 1983.

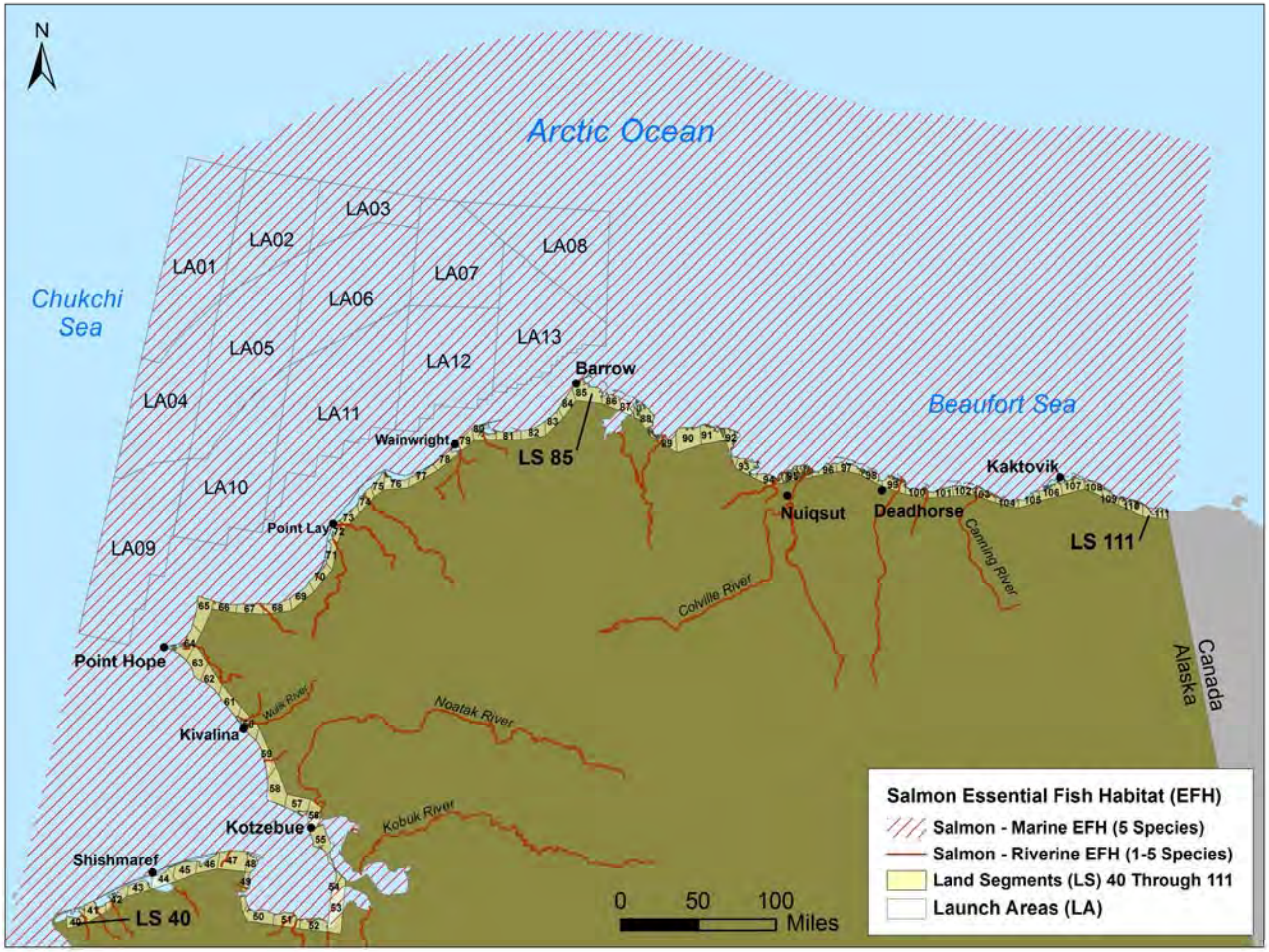

Figure C-1. Salmon: Essential Fish Habitat (EFH) in marine and riverine systems. (Source: NOAA, EFH, 2011). Also illustrated are LAs and LSs for the OSRA Model oil spill trajectory analysis.

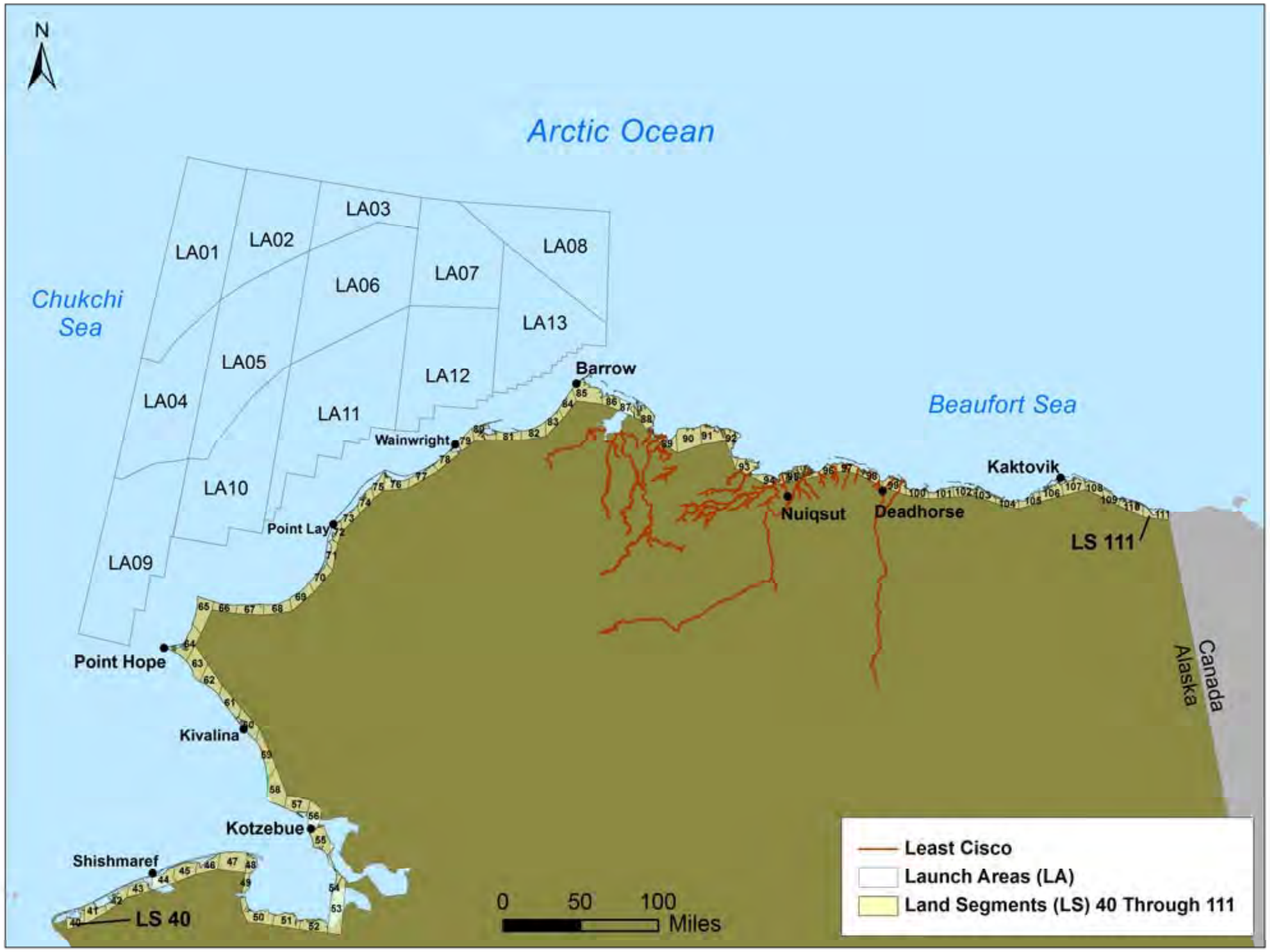

Figure C-2. Least cisco: Anadromous waters in northern Alaska. (Source: ADFG Anadromous Waters Catalog, 2011). Also illustrated are LAs and LSs for the OSRA Model oil spill trajectory analysis.

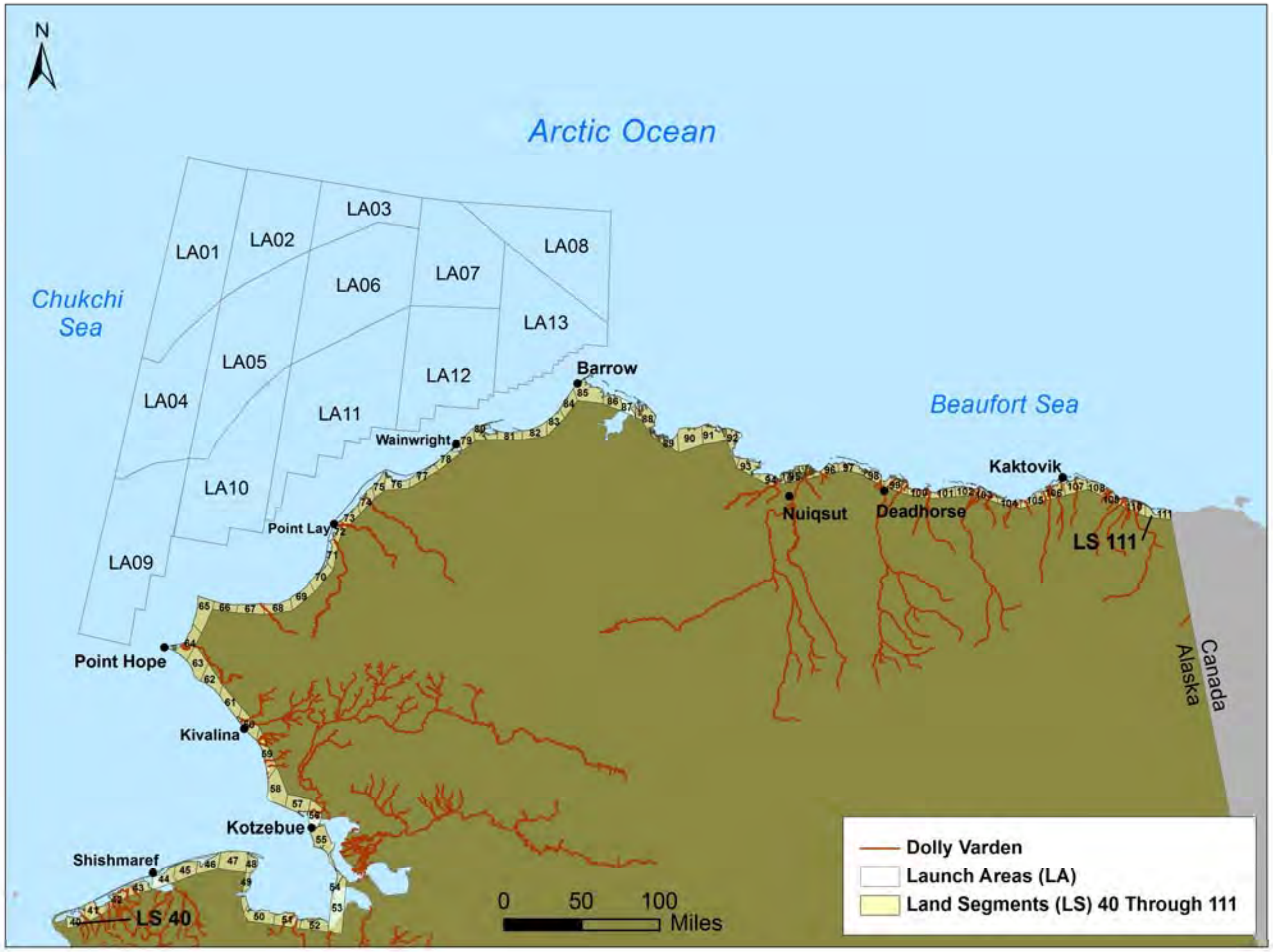

Figure C-3. Dolly varden: Anadromous waters in northern Alaska. (Source: ADFG Anadromous Waters Catalog, 2011). Also illustrated are LAs and LSs for the OSRA Model oil spill trajectory analysis.

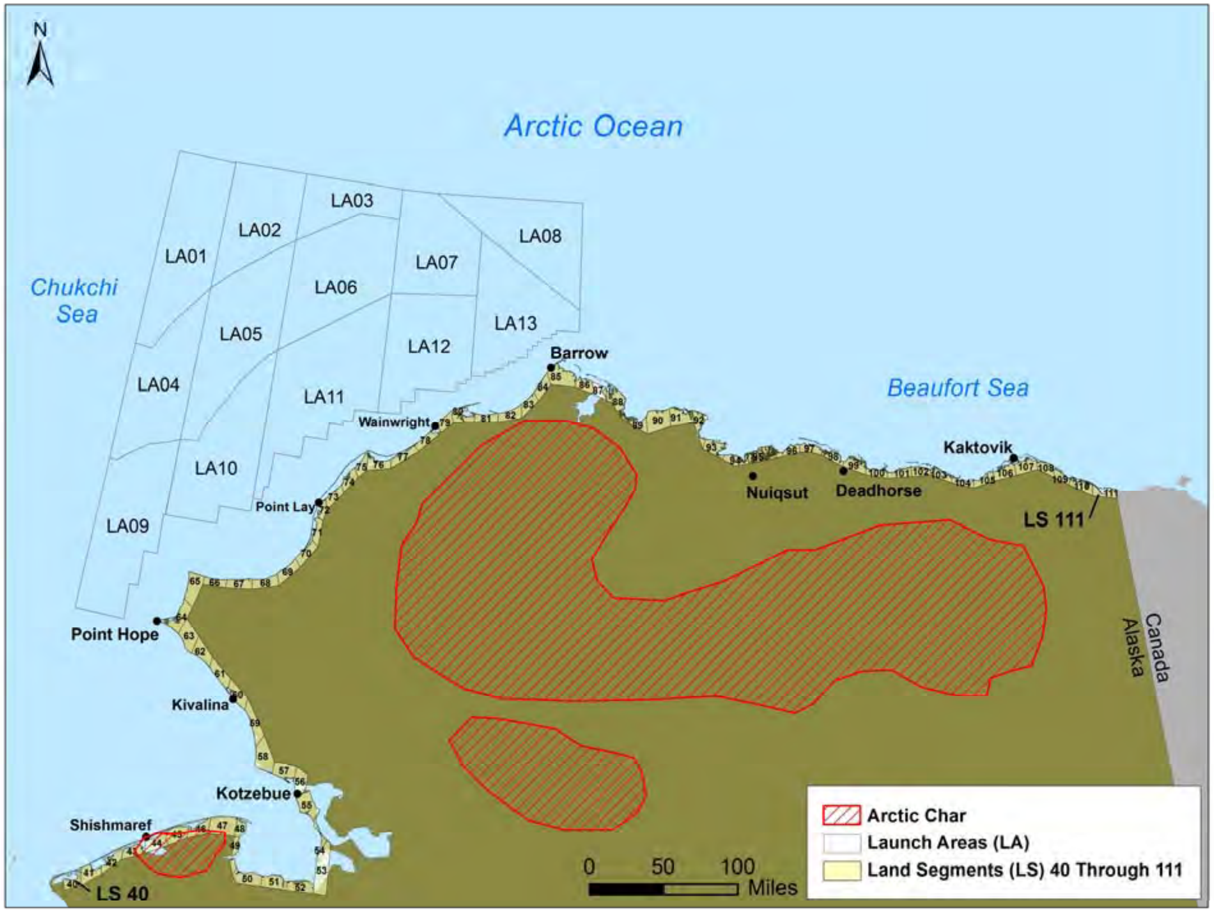

Figure C-4. Arctic char: Freshwater lake and stream habitats used in northern Alaska—Arctic char also range outside of their freshwater habitats into nearshore and marine waters. (Source: ADFG Anadromous Waters Catalog, 2011). Also illustrated are LAs and LSs for the OSRA Model oil spill trajectory analysis.

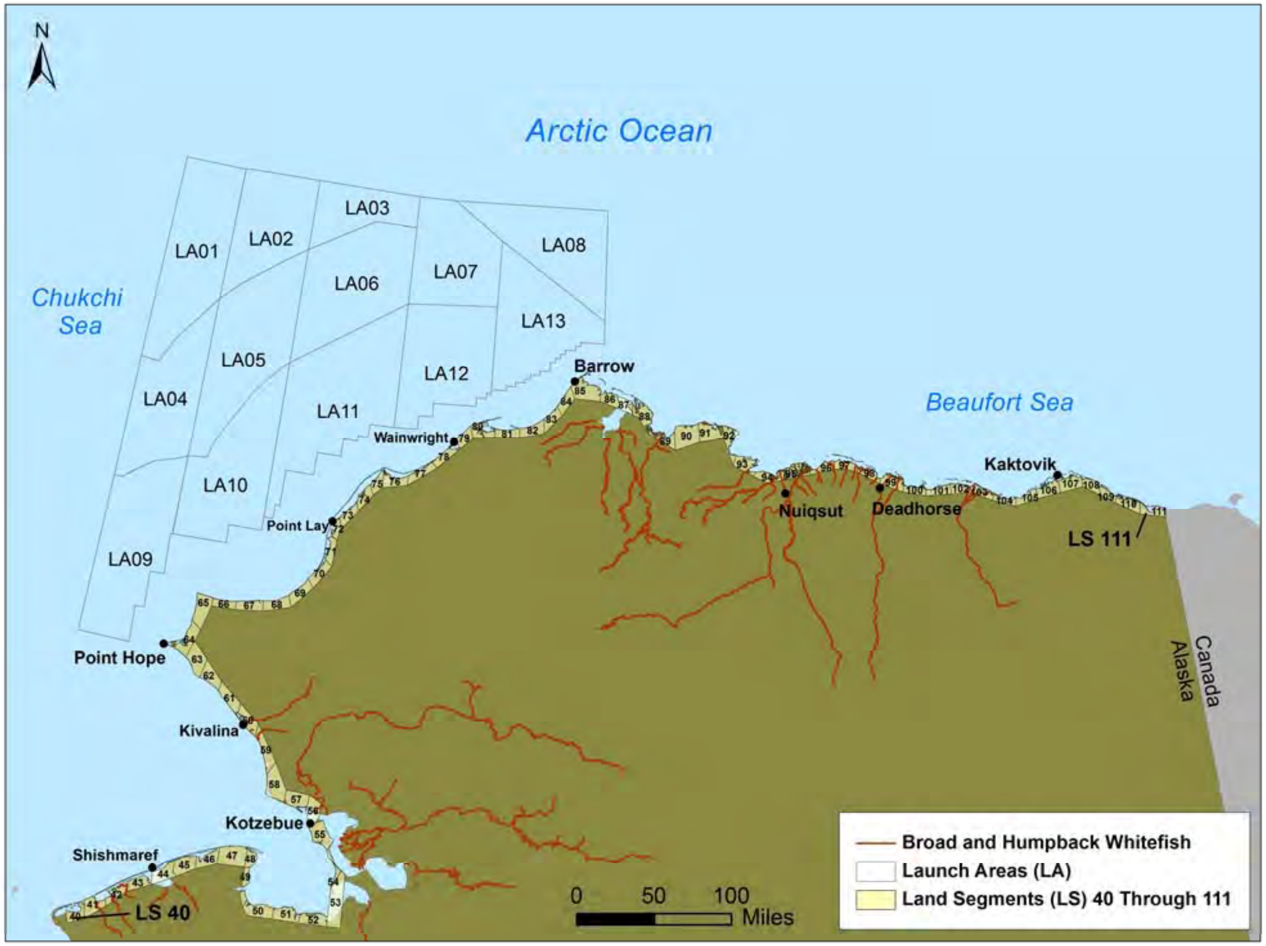

Figure C-5. Broad and humpback whitefish: Anadromous waters in northern Alaska. (Source: ADFG Anadromous Waters Catalog, 2011). Also illustrated are LAs and LSs for the OSRA Model oil spill trajectory analysis.

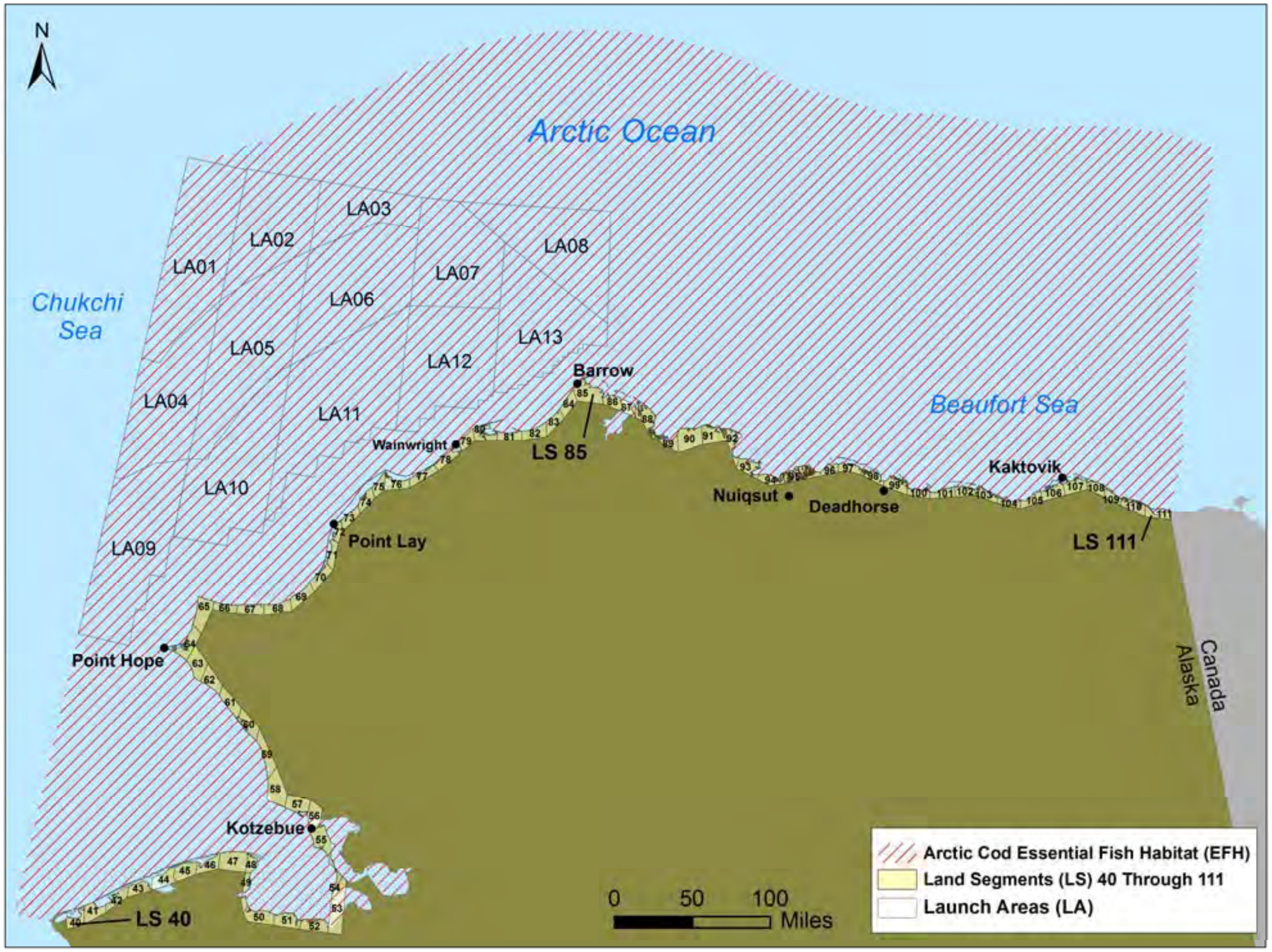

Figure C-6. Arctic cod: Essential Fish Habitat (EFH). (Source: NOAA, EFH, 2011). Also illustrated are LAs and LSs for the OSRA Model oil spill trajectory analysis.

Figure C-7. Saffron cod: Essential Fish Habitat (EFH). (Source: NOAA, EFH, 2011). Also illustrated are LAs and LSs for the OSRA Model oil spill trajectory analysis.

Figure C-8. Opilio crab: Essential Fish Habitat (EFH). (Source: NOAA, EFH, 2011). Also illustrated are LAs and LSs for the OSRA Model oil spill trajectory analysis.

Figure C-9. Coastal rivers and bays (including anadromous waters) of the Russia far east coast. Also illustrated are LAs and LSs for the OSRA Model oil spill trajectory analysis.

Estimate for a Very Large Oil Spill

From and Exploration Well

In the Chukchi Sea OCS Planning Area

NW Alaska

Table of Contents

List of Tables

List of Figures

Appendix D. Estimate for a Very Large Oil Spill

1. Purpose of Chukchi Sea VLOS Well Analysis

This document explains the methods by which BOEMRE created a simulation of a very large discharge event for a hypothetical reservoir in the Chukchi Sea. The purpose of creating this simulation is to provide a basis for evaluating the environmental consequences from a low probability, high impacts event—a high-volume and sustained blowout leading to a very large oil spill (VLOS) in the Chukchi Sea. To ensure that all potential environmental consequences of a VLOS are considered, this simulation characterizes the potential discharge from a well penetrating a known prospect that uniquely offers the maximum potential to achieve the highest flow rate of hydrocarbons and aggregate discharge among the many prospects in the Sale 193 lease area.

2. Selection of Geologic Model for Chukchi Sea VLOS Well

Among the prospects identified by BOEMRE seismic studies within the area of Chukchi Sea Lease Sale 193, a candidate prospect has been adopted as the site for a hypothetical blowout and discharge of oil into the marine environment from an exploration well. This candidate prospect was selected to maximize key geological characteristics that drive high flow rates—principally a thick reservoir offering high permeability—and was modeled for potential discharge volumes in a blowout event. The particular prospect is not known to contain oil or to offer rocks capable of performing as petroleum reservoirs. The geological model for the prospect is assumed to be a successful case and the considerable geological risk associated with the prospect is ignored. Lastly, the extremely low probability of a discharge event of the modeled magnitude is not considered in the analysis.

3. Point of Discharge into Marine Environment

The VLOS is assumed to originate from an exploration well at an unspecified location in the Chukchi Sea planning area and within the area identified in Figure D-1. The modeled point of discharge is the top of a blowout preventer coincident with the seafloor or “mudline” 131 ft below mean sea level (the base of the blowout preventer is placed at the bottom of a cellar ~40 ft deep for protection from iceberg keels; the top of the blowout preventer nearly reaches the seafloor). The association of the point of discharge with the blowout preventer is consistent with the BOEMRE protocol for determinations of worst-case discharges for proposed exploration and development wells.

4. Description of Relief Well Model

The oil discharge is assumed to terminate with the completion of a relief well after 74 days of flow, the longest time period among three possible scenarios described in Table D-1. The relief well scenarios were constructed by petroleum engineers within the office of Field Operations in the Alaska office of BOEMRE. The 74-day spill scenario assumes that a drilling platform located outside the Alaskan Arctic and somewhere in the North Pacific must be taken off an active project, re-fitted, and mobilized to the blowout site in the Chukchi Sea. No scenario for a “top-kill” or re-establishment of well flow control using the existing equipment and surface control techniques (often accomplished within a day) is entertained in this study.

5. The Gemini Solutions AVALON/MERLIN Computer Model

The computer model used to forecast the flow of fluids out of the Chukchi Sea VLOS well is a state-of-the-art proprietary commercial program by Gemini Solutions, Inc. of Richmond, Texas (http://www.geminisi.com/). The program is constructed as a desktop finite-difference simulator that divides the active flow system into many small cells and then iterates through time-increments of flow with re-assessments that successively modify the state of each cell in the flow system. Finite-difference models use approximations to relevant differential equations to calculate changes (e.g., pressures, fluid saturations, etc. in the case of fluid flow) within each cell. The incremental approach minimizes approximation errors by confining calculations to single cells and makes it possible to quantify behavior across complex systems with internal discontinuities (e.g., flow from reservoir to open well to casing to production manifold to pipeline, etc.). The model is robust, offering the capability to model fluid behavior through rank compositional data or through measured physical properties that can be used to forecast (through correlations) other properties.

The Gemini model consists of two components, "*AVALON*" and "*MERLIN*", that respectively simulate: (1) flow up a system of tubular passages (or "tubulars") and (2) inflow (into the bottom of a well) from a pressurized porous reservoir. The correlative capacities of these two components of the flow system determine the discharge rate that can be achieved through the exit point at the top of the well. In theory, the maximum possible discharge rate can be limited by either the aggregate outflow capacity of the tubulars or by the reservoir inflow capacity at the base of the well. In the design of development wells and take-away pipelines, these two components of the flow system (the tubulars and the reservoir) are balanced to achieve the most efficient long-term recovery of formation hydrocarbons from the field. For a high-yield reservoir like that modeled for the Chukchi Sea VLOS well, the discharge rate is usually limited by the choke effect of wellbore tubulars that are insufficient to accommodate inflow from the reservoir.

The flow up the open (uncased) wellbore and the casing is governed by the tubular sizes (diameter and length), roughness, frictional resistance, the driving formation pressure, and the density characteristics and thermal effects of the multiphase oil-gas-water mix (ranging from gassy liquid[s] to wet gas) moving upward through the wellbore. Flowing bottom-hole pressures at the base of the tubulars are a function of the aggregate density of the multiphase wellbore fluids, frictional and gravitational resistance to flow, ambient pressure (wellhead exterior), and reservoir pressure.

The inflow from the reservoir formation is chiefly governed by pore system size and connectivity, formation pressure, drive mechanism, fluid compositions, fluid properties at reservoir conditions of pressure and temperature, and length of the wellbore segment passing through the reservoir formation.

6. The Chukchi Sea VLOS Wellbore Design Model

The Chukchi Sea VLOS well has an assumed design standardized to wells drilled to targets at comparable depths on the Chukchi and Beaufort shelves in the past. Several strings of casing ranging from 30 to 13-3/8 inches in diameter are assembled and cemented in place as the well is deepened with a final interior string of 9-5/8 inch casing extending from the shale seal formation above the reservoir formation to the base of the blowout preventer. In practice, any problems with wellbore instability (spalling or caving of the wall of the wellbore) in the course of drilling might require a smaller casing string. However, the model assumes that no problems of this nature are encountered below either the 13-3/8 inch or 9-5/8 inch casing strings.

The blowout preventer rests in a cellar approximately 40 ft deep and 20 ft in diameter. The top of the blowout preventer reaches nearly to the mudline (sufficient distance below the mudline to be protected from iceberg keels, a requirement for the Arctic OCS). For purposes of the VLOS model, the 9-5/8-inch casing is assumed to extend up to the mudline. In effect, the blowout preventer is assumed to offer no resistance to flow but is simply an extension of the casing. The pressures exerted by the atmosphere and the seawater column together contribute approximately 73 psi to the flowing bottom-hole pressure that resists inflow at the face of the reservoir formation in the bottom part of the VLOS well. The 9-5/8-inch casing is assumed to have an internal diameter of 8.535 inches and this value partly controls throughput capacity. The wellbore below the casing is open (uncased) and passes through the reservoir formation to total depth. The open wellbore is assumed to be drilled with a bit 8.5 inches in diameter to a depth of 9,000 ft, with washout enlarging the wellbore to ~130% of gauge (~11 inches). The washout assumption has the effect of increasing discharge rate. Each segment of the flow path is also assigned a length and a roughness factor to evaluate frictional effects.

7. Proprietary Data in Chukchi Sea VLOS Well Model

Certain data related to the actual prospect modeled are uniquely derived from proprietary seismic data and cannot be revealed without compromising intellectual property rights and causing harm to the financial interests of leaseholders. These data include reservoir depth (and related details of casing design), specific well location, and targeted formation(s). In any case, these proprietary data are not directly relevant to the research issue at hand—the potential environmental impact of a sustained oil discharge from any source—and their exclusion from specific reference in this study does not detract from the conclusions of the study.

8. Darcy Radial Flow Equation and Basic Data for Discharge Model

The most important variables for the reservoir inflow component of the discharge model include the aggregate thickness of flow units (h), initial (pore) pressure (p_i), permeability (k_o) of the reservoir formation, and oil viscosity (μ_o). Inflow rates are particularly sensitive to permeability, which at extremes can vary across 7 orders of magnitude (0.01-1,000 md) or greater. Other important variables include oil viscosity and reservoir pressure. However, other important variables can vary by several factors.

The flow of fluids out of a reservoir and into a well, or "inflow," is grossly governed by the Darcy radial flow equation, as summarized in its simplest form for an oil reservoir below. The purpose of including the equation here is to illustrate the roles of the key variables in determining flow rate, denoted in the convention of petroleum engineers as "q_o". Note that no flow-limiting constraints are imposed upon outflow by the well tubular configuration above the reservoir in the basic Darcy equation.

Darcy radial flow *(steady-state) equation from Ahmed (2010, p. 435, equation 6-144)*

$$q_o = \frac{0.00708 * k_o * h * (p_i - p_{wf})}{\mu_o * B_{oi} * ((\ln r_e / r_w) + S)}$$

where

q_o= oil flow rate, barrels/day;
k_o=permeability to oil, md, typically 0.01- >1,000 md;
h= thickness, ft, typically 10-200 ft;
p_i = initial reservoir pore pressure, psi, typically 1,500-20,000 psi;
p_{wf} = bottom-hole flowing pressure, psi, typically 300-8,000 psi;
μ_o = oil viscosity, cp, typically 0.1 to 30.0 cp;
B_{oi} = oil formation volume factor, reservoir bbls per stock-tank bbl, typically 1.0-3.0;
r_e = drainage radius, ft, typically 1,000-20,000 ft;
r_w = radius of well, ft, typically 0.35 to 0.73 ft;
S = skin factor, dimensionless, typically 0-500.

Many other variables of lesser importance that do not appear in the Darcy radial flow equation are required for the *AVALON/MERLIN* reservoir inflow model. Table D-2 summarizes some of the key reservoir and fluid properties and model parameters that formed the input data to the reservoir inflow model. Variables that appear in the Darcy radial flow equation above are highlighted.

In the Chukchi Sea VLOS well oil discharge model, no factors related to the near-wellbore alteration of the reservoir formation that might limit flow rate or arrest the discharge were employed. The "skin factor (S)" shown in the Darcy radial flow equation above usually quantifies the plugging of reservoir pores (by drilling fluid solids) that often accompanies the drilling of a well; for the VLOS model "S" is set to zero (no effect on discharge rate). The model further assumes no influx into the well of brines from the aquifer beneath the oil pool or from separate brine-bearing sandstones that intersect the wellbore. In addition, no "bridging" or collapse of the open segment of the wellbore was assumed to restrict or terminate flow. No near-wellbore reservoir boundaries (such as faults) were invoked to limit the potential drainage area.

Reservoir pressure and temperature are forecast from data collected in the 5 exploration wells in the Chukchi Sea in the 1989-1991 drilling program that followed the 1988 lease sale (109). Reservoir formation identification at the subject prospect is a result of extending formation boundaries away from well control both offshore and onshore through a grid of proprietary seismic data, including recently-acquired three-dimensional (3D) seismic data. Estimates for reservoir porosity and permeability are based on regional analog fields and well penetrations outside of oil fields.

The aggregate thickness of flow units is based upon a synthesis of proprietary seismic mapping that defines the shape of a capture volume, or trap, which is assumed to be completely filled with oil. The seismic mapping locates and measures the point of the maximum vertical thickness of the capture volume, which is where the VLOS well is sited. Therefore, the exact location of the VLOS well represents proprietary information and is not disclosed. The vertical thickness of the oil-filled capture volume is reduced to an aggregate flow unit thickness by the expected ratio of porous flow units to overall formation thickness as forecast from analog fields and well penetrations.

The area drained by the blowout event is assumed to be 160 acres (equivalent radius [r_e] surrounding well = 1,490 ft). The oil saturation model is based on the porosity and permeability models, assumptions about the texture (sorting, particle size) of the porous units in the reservoir formation, and reference to analog fields.

The oil discharged from the Chukchi Sea VLOS well is assumed to be low-sulfur 35° API crude oil like that recovered at the Klondike 1 well, here informally termed the "Klondike oil." The Klondike oil was recovered when the drill string was pulled out of the well to repair a plugged jet in the bit. The lifting of the drill string reduced wellbore pressure in the lower part of the well and thereby drew the oil out of the formation and into the wellbore. At the time of the bit repair trip, the part of the wellbore that was uncased or "open" extended from 9,093 ft to 9,916 ft md. This "swabbed" oil was subsequently circulated to the surface with drilling fluids and an unspecified quantity was collected as samples. The Klondike oil had a gravity of 35.3°API, a sulfur content of 0.18%, a ratio of *saturates:aromatics:non-hydrocarbons = 66.2:26.1:7.7, a ratio of normal paraffins:isoalkanes + cycloalkanes:aromatics:non-hydrocarbons = 22.4:43.8::26.1:7.7* (Klondike 1 well, 1989) and would be classified as a paraffinic-naphthenic oil (Tissot and Welte, Table IV.2.2, p. 418). The low-sulfur and high-gravity qualities of the Klondike oil resemble the Simpson, Umiat, Tarn, and Alpine oils of the North Slope of Alaska (Figure D-2a). However, unlike the Simpson, Umiat, and Tarn oils, the Klondike oil is isotopically "light" (or deficient [relatively more negative value for ΔC^{13}] in the content of the heavier carbon isotope C^{13} relative to C^{12}). The isotopic composition of the Klondike oil most resembles the Jurassic (Kingak Formation)-sourced oils of Alpine field and at the Kavearak Point well (Figure D-2b). However, the ratio of C^{29} Terpane/Hopane for the Klondike oil is 0.77; values exceeding 0.75 suggest contribution from marine carbonate (Peters et al., 2007, tbl. 3, p. 883 & 893), possibly pointing to the carbonates of the Triassic Shublik Formation as a second contributing source. The Klondike oil is assumed to represent the dominant (Triassic/Jurassic-sourced) petroleum system in the central Chukchi Sea because of its composition and because it was extracted from a sequence of rocks that includes very rich oil source rocks of the Shublik (Upper Triassic) and Fire Creek (Lower Triassic) Formations. No oil source rocks of Jurassic age were penetrated in the Klondike 1 well but such rocks are probably preserved in nearby areas flanking the Klondike structure.

The oil in the VLOS reservoir is assumed to be initially saturated (contains the maximum amount of dissolved gas possible at the inferred reservoir temperature and pressure). Therefore, the bubble-point pressure (pressure at which dissolved gas breaks out of solution and forms bubbles in the oil) is assumed to equal the initial reservoir pressure (pi). No significant gas cap is assumed to be present in order to maximize the vertical thickness of the oil column. The pressure-temperature model, the oil gravity, and the assumption of saturation then lead through various correlations and calculations to estimates for B_{oi} (oil volume factor, in reservoir barrels [rb] per surface or "stock tank" barrel [stb]), Rsi (dissolved gas content, in surface or standard cubic ft [scf] per stock tank barrel [stb]), μ_o (oil viscosity, in centipoise [cp]), reservoir oil density (g/cm^3), and static pressure gradient for reservoir oil (in psi/ft). In some basins, these types of data are sometimes available through laboratory "PVT" (pressure-volume tests at constant temperature) studies of oil recovered in nearby wells. However, for the Chukchi Sea VLOS well, no relevant PVT studies are available and many key fluid and rock parameters were of necessity obtained through estimates for pressure and temperature and use of industry-accepted correlations as published by many sources including Craft and Hawkins (1959), Standing (1977, and other references therein), McCain (1973, and references therein), and Ahmed (2010, and many references therein).

The drive mechanism for the blowout flow is assumed to be pressure depletion and expansion of exsolved solution gas. The estimate for specific gas gravity is based on analyses of gas samples obtained by tests at the Burger 1 and Popcorn 1 wells on the Chukchi shelf. Estimates for fluid and rock compressibility are based upon assumptions about rock consolidation, porosity, pressure, temperature, dissolved gas content, relative fluid saturations, and brine composition. The brine salinity is assumed to be similar to seawater and that assumption is supported by analyses of connate water recovered at the Burger 1 well. The estimate for brine viscosity is based upon the salinity assumption and reservoir temperature. The model-implied in-place oil volume (reduced to surface barrels) is calculated as 869 bbls/acre-ft, as shown at the bottom of Table D-2. Joining the implied in-place oil volume with thickness (h) and a 160-acre assumed drainage area indicates an in-place volume of 25,722,400 bbls of oil within the model drainage area. Probably less than half of this in-place oil could be recovered by a single well, even over decades of carefully-engineered production and enhanced recovery techniques. Only a very small fraction of this in-place oil will reach the surface during the hypothetical VLOS.

9. Discharge Model Results for the Chukchi Sea VLOS Well

Table D-3 and Figure D-3 summarize the results of the discharge model for the Chukchi Sea VLOS Well. Following the blowout, the oil discharge climbs rapidly to a maximum of 61,672 bbls/d during day 1. After peaking in day 1, Figure D-3 shows that the oil discharge rate declines rapidly through the first 40 days of flow as the reservoir is depressurized by approximately 1,400 psi (Table D-3). The decline in the flow rate flattens somewhat after day 40, finally falling to 20,479 bbls/d (33% of the day 1 peak rate) by day 74 when the near-wellbore reservoir pressure has fallen to 58% of the initial reservoir pressure (4,392 psi). As shown at the bottom of Table D-3, the cumulative oil discharge over the 74-day discharge period is 2,160,200 bbls. As shown in Table D-3, water production over the 74-day period is quite small (cumulative water: 28.8 bbls). The water discharge is limited because in the oil-saturated reservoir the small amount of water is bound to the walls of pores and because the relative permeability to oil is much higher. In addition, the model is designed to preclude any brine-saturated reservoir from direct contact with the wellbore.

10. Patterns of Fluid Discharges from the Chukchi Sea VLOS Well

The decline in discharge rates of both oil and gas during the early part of the flow period are on the order of 99% per year and reflect rapid de-pressurization of the reservoir near the wellbore. The oil discharge rate declines throughout the entire 74-day period. However, the gas discharge rate declines to a minimum of 19,513 Mcf/d on day 45 and then, despite continuing reservoir depressurization, reverses the decline and rises to 24,608 Mcf/d by the end of the 74-day period. This behavior is caused by the evolving compositions of the fluids that remain in the reservoir pore system as oil is withdrawn. One clue to how the reservoir contents are changing is the change in produced gas-oil ratio through the 74-day flow period, as discussed below.

The oil in the VLOS reservoir is estimated to be originally saturated with 930 scf/stb of dissolved (solution) gas and this is reflected by the identical initial produced gas-oil ratio of 930 scf/stb in the flow model (time 0.1 days, Table D-3). As shown in Table D-3 and Figure D-3, the produced gas-oil ratio falls from the initial value of 930 scf/stb into a protracted minimum of approximately 757 scf/stb from day 15 to day 27, thereafter rising steadily to 1,202 scf/stb by day 74. This is a consequence of the increasing enrichment or “saturation” of the reservoir pore system with bubbles of free gas as pressure declines and dissolved gas breaks out of the oil and forms a separate phase in the centers of pores. At the onset of flow, and through the first 27 days of flow, gas bubbles are forming within the reservoir near the wellbore, but high oil saturation and correlative low relative permeability to gas blocks the movement of the gas bubbles through the pores in the reservoir and thence to the well. As oil flow continues, the oil saturation declines while gas saturation rises and gas eventually becomes the dominant phase. By day 27, a large volume of the reservoir near the wellbore hosts high free gas saturations and gas can easily flow to the wellbore. Thus, we observe that the gas rate and the produced gas-oil ratio both steadily rise, to 24,608 Mcf/d and 1,202 scf/stb respectively, by the end of the 74-day flow period. Essentially, the original VLOS oil reservoir is being converted to a gas reservoir. Ultimately, beyond the 74-day period shown in Figure D-3, gas production will peak and then decline as the reservoir drains to complete depletion of extractable oil and gas.

TABLES

Table D-1. Estimates for time periods required to drill a relief well and to kill the discharge at the Chukchi Sea VLOS well (provided by BOEMRE AKOCSR Field Operations office). Model 3 provides the largest and most protracted discharge and forms the basis for the present study.

Relief Well Models for Chukchi Sea VLOS Well

1. Use of Original Drilling Platform and Equipment to Drill Relief Well

Activity	Time Estimate (days)
Cleanup and Re-Supply of Original Vessel	5
Construction of Relief Well Cellar *	7
Drilling of Relief Well	18
Killing of VLOS (Original) Well	5
Weather Downtime *	4
Total Required Time	*39*

2. Use of Second Drilling Platform and Equipment Pre-Positioned In-Theater (Within Chukchi Sea) for Relief Well

Activity	Time Estimate (days)
Plug and Temporarily Abandon Well Being Drilled by Second Drilling Platform	5
Cleanup and Re-Supply of Relief Well Vessel	5
Transport of Relief Well Rig to VLOS Well Site	2
Construction of Relief Well Cellar *	7
Drilling of Relief Well	18
Killing of VLOS (Original) Well	5
Weather Downtime *	4
Total Required Time	*46*

3. Use of Second Drilling Platform and Equipment from Northern

Activity	Time Estimate (days)
Plug and Temporarily Abandon Well Being Drilled by Second (Relief Well) Drilling Platform	5
Cleanup of Relief Well Vessel (Performed En Route-No Additional Time)	0
Transport of Relief Well Rig to VLOS Well Site	30
Re-Supply of Relief Well Vessel	5
Construction of Relief Well Cellar *	7
Drilling of Relief Well	18
Killing of VLOS (Original) Well	5
Weather Downtime *	4
Total Required Time	*74*

** estimates based upon previous operations in the area*

Table D-2. Selected key input variables for reservoir inflow simulation element of Chukchi Sea VLOS well discharge model using AVALON/MERLIN software.

Initial Reservoir Pressure (**p_i**, psi)	4,392	Bubble Point Pressure (psi)	4,392
Flowing Bottom-Hole Pressure (**p_{wf}**, psi) - Modeled by *AVALON/MERLIN*	1,853 - 3,760	Oil Viscosity (**μ_o**, cp)	0.47
Reservoir Temperature, °F (°R)	176 (636)	Skin Factor (**S**)	0
Reservoir Porosity (fraction of rock)	0.21	Reservoir Oil Density (g/cm^3)	0.68
Reservoir Permeability (**k_o**, md)	400	Static Pressure Gradient of Reservoir Oil (psi/ft)	0.295
Aggregate Thickness Flow Units (**h**, ft)	185	Specific Gas Gravity (Air=1.0)	0.6
Drainage Radius (**r_e**, ft)	1,490	Formation Compressibility, Cf (v/v/psi*10^{-6})	3.6
Well Radius at Reservoir (**r_W**, ft)	0.46	Oil Compressibility, Co (v/v/psi*10^{-6})	13.031
Initial Oil Saturation (fraction of porosity)	0.76	Brine Compressibility, Cw (v/v/psi*10^{-6})	3.25
Critical Oil Saturation (fraction of porosity)	0.2	Total Compressibility, Ct (v/v/psi*10^{-6})	14.284
Oil Gravity (°API)	35	Brine Salinity (ppm NaCl)	35,000
Initial **Boi** or FVF (rb/stb)	1.425	Brine Viscosity (cp)	0.37
Initial Rsi or GOR (scf/stb)	930	Implied In-Place Oil Volume (bbls/acre-ft at 1 atm. and 60°F)	869

psi, pounds per square inch; °R, °Rankine (=°F+460); Boi, oil volume factor (aka FVF or formation volume factor); rb/stb, reservoir barrels per stock-tank barrel of oil (at 1 atm. and 60°F); Rsi, gas saturation (aka GOR or gas-oil ratio); scf/stb, standard cubic feet of gas per stock-tank barrel of oil (at 1 atm. and 60°F); cp, centipoise; model-implied in-place oil=7,758.38 bbls/acre-ft(0.21*(0.76)/1.425). Highlighted variables appear in the Darcy radial flow equation.*

Table D-3. Results of AVALON/MERLIN discharge model for Chukchi Sea VLOS well over maximum (74-day) time period estimated for mobilization, drilling, and completion of a relief well.

Time (days)	Oil Discharge Rate (bbls/d)	Gas Discharge Rate (Mcf/d)	Producing Rsi (GOR) Gas-Oil Ratio (scf/stb)	Water Discharge Rate (bbls/d)	Cumulative Oil Discharge (Mbbls)	Cumulative Gas Discharge (MMcf)	Cumulative Water Discharge (bbls)	Near-Wellbore Reservoir Pressure (psi)
0	0	0	930	0	0	0.0	0	4,392
0.1	50,671	47,124	930	0.06	5.1	4.7	0.0	4,168
1	61,672	50,677	822	0.16	61.8	52.2	0.1	3,937
2	57,485	46,357	806	0.18	120.5	99.8	0.3	3,875
3	53,987	43,035	797	0.20	175.1	143.5	0.5	3,827
4	52,246	41,030	785	0.23	226.1	183.9	0.7	3,777
5	48,669	38,101	783	0.23	274.8	222.0	1.0	3,747
6	46,581	36,312	780	0.25	321.4	258.4	1.2	3,707
7	45,036	34,931	776	0.26	366.4	293.3	1.5	3,666
8	43,596	33,607	771	0.27	410.0	326.9	1.7	3,627
9	42,239	32,343	766	0.28	452.2	359.2	2.0	3,591
10	40,889	31,100	761	0.29	493.1	390.3	2.3	3,558
11	39,529	29,923	757	0.29	532.6	420.3	2.6	3,528
12	38,306	28,974	756	0.30	570.9	449.2	2.9	3,499
13	37,219	28,148	756	0.30	608.2	477.4	3.2	3,473
14	36,364	27,583	759	0.31	644.5	505.0	3.5	3,445
15	35,580	27,035	760	0.32	680.1	532.0	3.8	3,420
16	34,930	26,628	762	0.33	715.0	558.6	4.2	3,394
17	34,316	26,178	763	0.33	749.4	584.8	4.5	3,370
18	33,750	25,767	763	0.34	783.1	610.6	4.8	3,347
19	33,199	25,330	763	0.34	816.3	635.9	5.2	3,325
20	32,662	24,885	762	0.35	849.0	660.8	5.5	3,304
21	32,130	24,436	761	0.35	881.1	685.2	5.9	3,284
22	31,608	23,995	759	0.35	912.7	709.2	6.2	3,265
23	31,094	23,577	758	0.35	943.8	732.8	6.6	3,247
24	30,596	23,178	758	0.36	974.4	756.0	6.9	3,230
25	30,115	22,800	757	0.36	1,004.5	778.8	7.3	3,213
26	29,648	22,443	757	0.36	1,034.2	801.2	7.7	3,197
27	29,200	22,110	757	0.36	1,063.4	823.3	8.0	3,181
28	28,750	21,788	758	0.36	1,092.1	845.1	8.4	3,165
29	28,319	21,499	759	0.36	1,120.4	866.6	8.7	3,150
30	27,917	21,245	761	0.37	1,148.3	887.9	9.1	3,136
31	27,539	21,029	764	0.37	1,175.9	908.9	9.5	3,121
32	27,166	20,806	766	0.37	1,203.0	929.7	9.9	3,106
33	26,805	20,599	768	0.37	1,229.9	950.3	10.2	3,092
34	26,452	20,415	772	0.37	1,256.3	970.7	10.6	3,079
35	26,124	20,256	775	0.38	1,282.4	991.0	11.0	3,065
36	25,817	20,115	779	0.38	1,308.2	1011.1	11.4	3,052
37	25,534	20,006	784	0.38	1,333.8	1031.1	11.7	3,038
38	25,250	19,886	788	0.38	1,359.0	1051.0	12.1	3,025
39	24,974	19,787	792	0.39	1,384.0	1070.8	12.5	3,012
40	24,719	19,707	797	0.39	1,408.7	1090.5	12.9	2,999
41	24,474	19,637	802	0.39	1,433.2	1110.1	13.3	2,986
42	24,251	19,595	808	0.39	1,457.4	1129.7	13.7	2,973
43	24,034	19,552	814	0.40	1,481.5	1149.2	14.1	2,961
44	23,821	19,522	820	0.40	1,505.3	1168.8	14.5	2,948
45	23,620	19,513	826	0.40	1,528.9	1188.3	14.9	2,936
46	23,434	19,518	833	0.41	1,552.4	1207.8	15.3	2,923
47	23,259	19,531	840	0.41	1,575.6	1227.3	15.7	2,911
48	23,110	19,579	847	0.42	1,598.7	1246.9	16.1	2,898
49	22,946	19,617	855	0.42	1,621.7	1266.5	16.5	2,885
50	22,797	19,682	863	0.42	1,644.5	1286.2	17.0	2,873
51	22,665	19,765	872	0.43	1,667.1	1306.0	17.4	2,860
52	22,543	19,856	881	0.43	1,689.7	1325.8	17.8	2,847
53	22,434	19,972	890	0.44	1,712.1	1345.8	18.3	2,835
54	22,325	20,098	900	0.44	1,734.4	1365.9	18.7	2,822
55	22,228	20,252	911	0.45	1,756.7	1386.2	19.2	2,809
56	22,150	20,425	922	0.46	1,778.8	1406.6	19.6	2,795
57	22,042	20,566	933	0.46	1,800.9	1427.1	20.1	2,783
58	21,918	20,699	944	0.47	1,822.8	1447.8	20.6	2,770
59	21,807	20,869	957	0.47	1,844.6	1468.7	21.0	2,758
60	21,688	21,030	970	0.48	1,866.3	1489.7	21.5	2,745
61	21,580	21,203	983	0.48	1,887.8	1510.9	22.0	2,733
62	21,475	21,381	996	0.49	1,909.3	1532.3	22.5	2,720
63	21,369	21,566	1,009	0.49	1,930.7	1553.9	23.0	2,708
64	21,284	21,804	1,024	0.50	1,952.0	1575.7	23.5	2,695
65	21,193	22,032	1,040	0.51	1,973.2	1597.7	24.0	2,683
66	21,112	22,276	1,055	0.51	1,994.3	1620.0	24.5	2,670
67	21,033	22,532	1,071	0.52	2,015.3	1642.5	25.0	2,657
68	20,955	22,799	1,088	0.53	2,036.3	1665.3	25.5	2,644
69	20,868	23,078	1,106	0.53	2,057.1	1688.4	26.1	2,632
70	20,777	23,350	1,124	0.54	2,077.9	1711.8	26.6	2,619
71	20,693	23,637	1,142	0.55	2,098.6	1735.4	27.2	2,606
72	20,615	23,934	1,161	0.55	2,119.2	1759.3	27.7	2,594
73	20,539	24,248	1,181	0.56	2,139.8	1783.6	28.3	2,581
74	20,479	24,608	1,202	0.57	2,160.2	1808.2	28.8	2,567

Mcf/d, thousands of cubic feet per day; scf/stb, standard cubic feet or gas per stock-tank barrel of oil at 1 atmosphere (101.6 kilopascals) and 60°F (15.6°C) or surface conditions; Mbbls, thousands of barrels; MMcf, millions of cubic feet; psi, pounds per square inch (6.895 kiloipascals). "Near-Wellbore Reservoir Pressure" represents the formation pressure in the cell penetrated by the well.

FIGURES

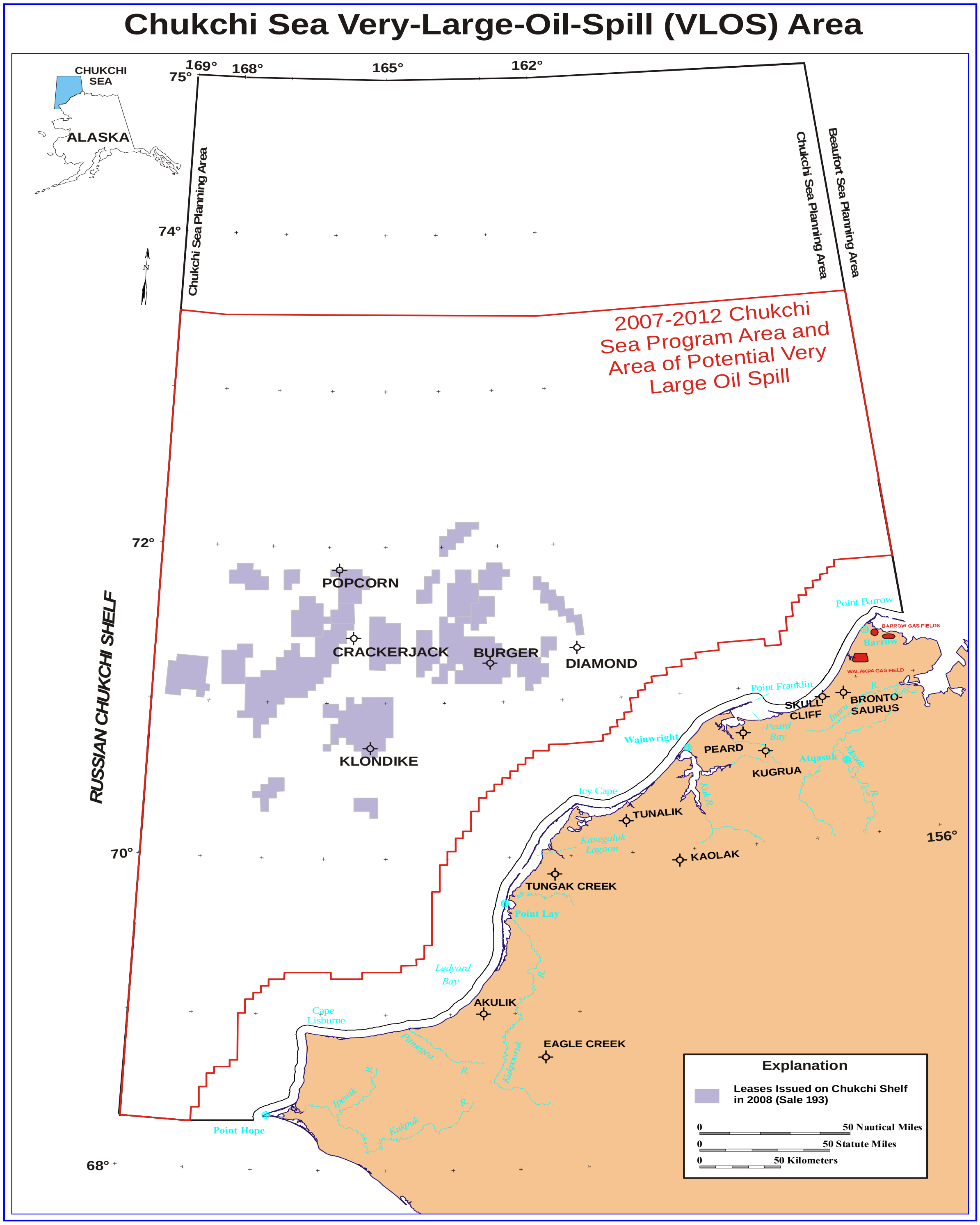

Figure D-1. Map of Chukchi Sea planning area with Sale 193 leased acreage.

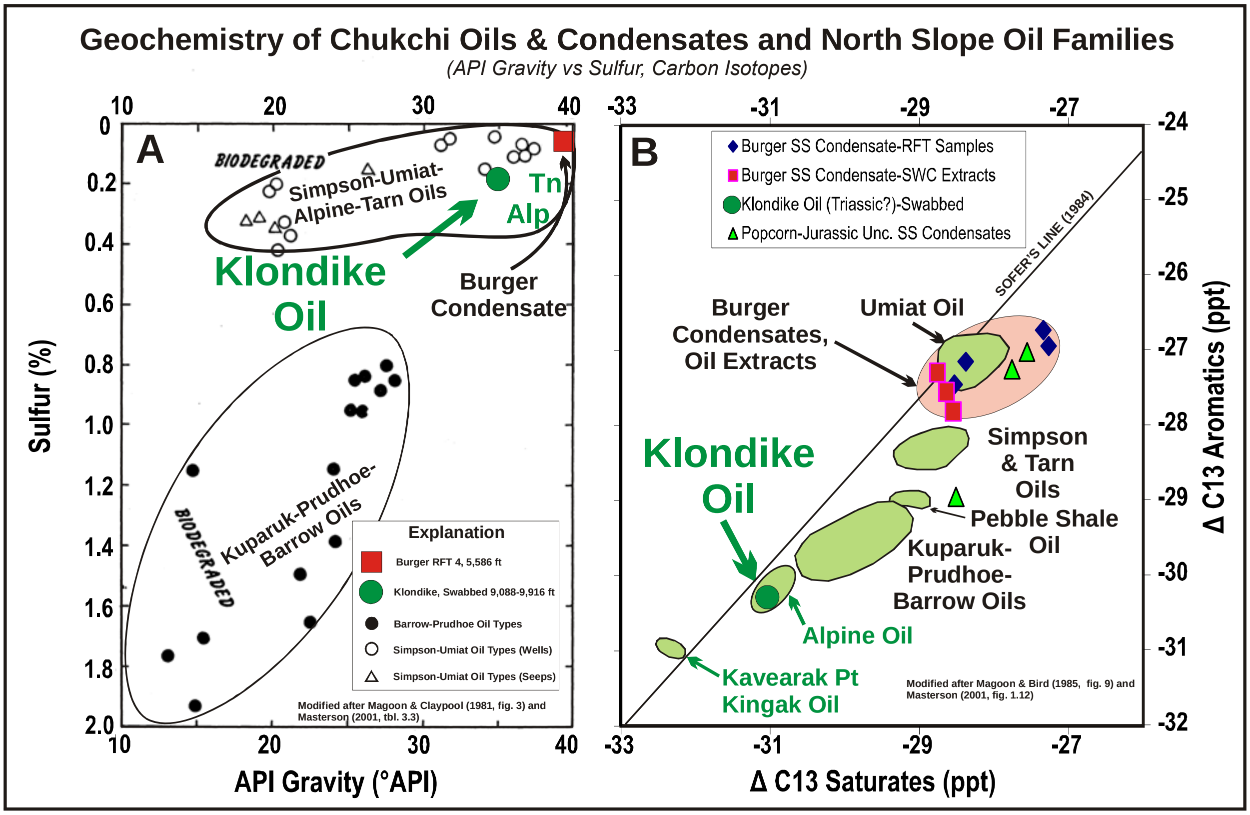

Figure D-2. A) Klondike oil gravity and sulfur content as compared to Burger condensates and North Slope oil types (Tn = Tarn oil; Alp = Alpine oil); B) Isotopic composition of Klondike oil as compared to Burger condensates and extracted oils and North Slope oil types

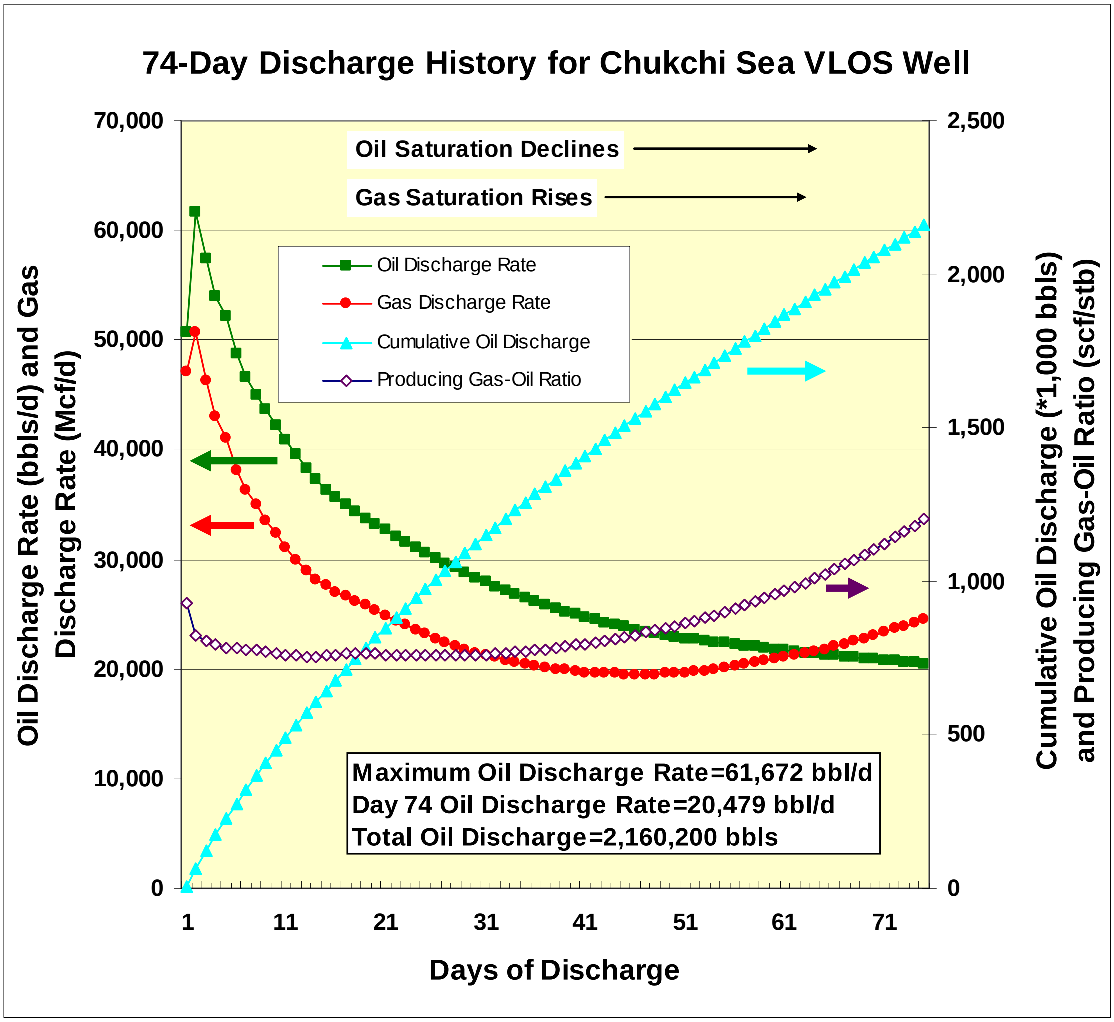

Figure D-3. Graph profiling daily oil and gas discharge rates, producing gas-oil ratio, and cumulative oil discharge over 74-day period of discharge from the Chukchi Sea VLOS well.

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.