Alaska Outer Continental Shelf

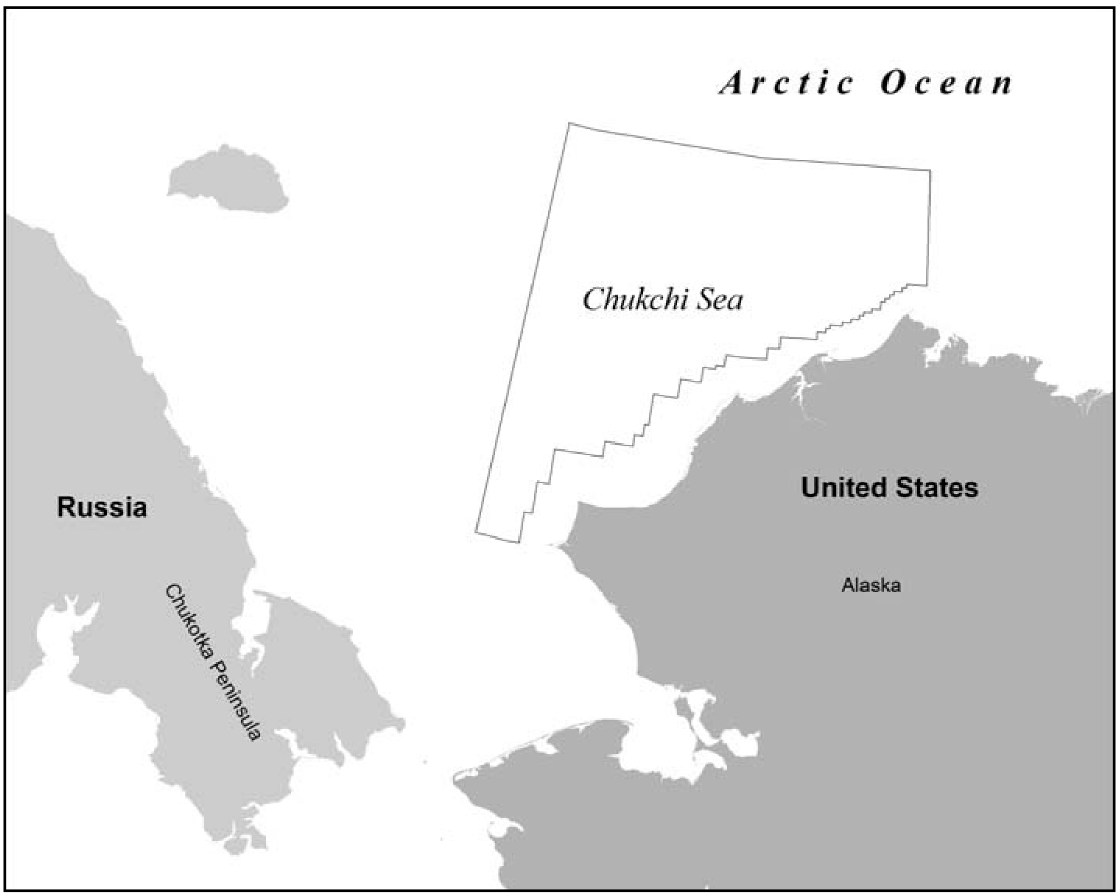
OCS EIS/EA
BOEM 2014-669

Chukchi Sea Planning Area

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

Final Second Supplemental Environmental Impact Statement

Volume 1. Chapters 1-7



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Prepared by
Bureau of Ocean Energy Management
Alaska OCS Region

Cooperating Agencies
U.S. Department of the Interior
Bureau of Safety and Environmental Enforcement
Bureau of Land Management

State of Alaska
Department of Natural Resources
Office of Project Management and Permitting

North Slope Borough

North West Arctic Borough

U.S. Department of the Interior
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February 2015

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COVER SHEET

Chukchi Sea
Lease Sale 193
Final Second 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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North Slope Borough

Arctic Borough

Abstract:

This Final Second Supplemental Environmental Impact Statement (SEIS) addresses Outer Continental Shelf (OCS) Oil and Gas Lease Sale 193, Chukchi Sea, Alaska. Pursuant to a January 22, 2014, U.S. Court of Appeals for the Ninth Circuit remand, BOEM has completed this Second SEIS process by publishing a draft Second SEIS, holding public hearings, conducting government-to-government consultations, and providing a public comment period following publication of the Draft Second SEIS. More than 430,000 comments were received from various entities. BOEM has considered and responded to these comments. The Final Second SEIS analyzes the potential environmental effects of potential oil and gas activities associated with Lease Sale 193. This analysis is based on a new exploration and development scenario of 4.3 billion barrels of oil and 2.2 trillion cubic feet of natural gas, and includes: a new Exploration and Development Scenario, analysis based on a review of new literature, new information on habitats, and new information on how resources could be affected by impact producing factors, updated description of the affected environment, resource-specific impact analyses, application of the principles of Integrated Arctic Management, cumulative impacts analyses, and consideration of alternatives and mitigations to reduce identified potential impacts.

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Acronyms and Abbreviations

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Acronyms and Abbreviations

2D............................ two-dimensional
3D............................ three-dimensional
°C............................ degrees Celsius
°F .... degrees Fahrenheit
μg/cm^3 .... micrograms per cubic centimeter
μg/g .... micrograms per gram
μg/m^3 .... micrograms per cubic meter
μg/L......................... micrograms per liter
μPa microPascal
AAC .... Alaska Administrative Code
ABL......................... Air boundary layer
ACCGIH.................. American Conference of Government Industrial Hygienists
ACIA .... Arctic Climate Impact Assessment
ACMP...................... Alaska Coastal Management Program
ACP .... Arctic Coastal Plain
ADCCED .... Alaska Department of Commerce, Community, and Economic Development
ADEC .... Alaska Department of Environmental Conservation
ADF&G................... Alaska Department of Fish and Game
ADNR...................... Alaska Department of Natural Resources
ADOLWD .... Alaska Department of Labor and Workforce Development
AEWC .... Alaska Eskimo Whaling Commission
AFMP .... Arctic Fishery Management Plan
AFN......................... Alaska Federation of Natives
AGL......................... above ground level
AHRS .... Alaska Heritage Resources Survey
AI/AN...................... American Indian and Alaskan Native populations
AK LNG.................. Alaska Liquefied Natural Gas Pipeline Project
AKNHP .... Alaska Natural Heritage Program
AKPDES .... Alaska Pollutant Discharge Elimination System
AMAP .... Arctic Monitoring and Assessment Programme
AMNWR .... Alaska Maritime National Wildlife Refuge
ANC .... Alaska Nanuuq Commission
ANCSA .... Alaska Native Claims Settlement Act
ANILCA.................. Alaska National Interest Land Conservation Act
ANIMIDA .... Arctic Nearshore Impact Monitoring in the Development Area
ANS......................... Aquatic Nuisance Species or Alaska North Slope
ANSO .... Alaska North Slope Oil
ANWR..................... Arctic National Wildlife Refuge
AO .... Arctic Oscillation
AOCSR.................... Alaska OCS Region
AOOS .... Alaska Ocean Observing System
APD .... Application for Permit to Drill
API .... American Petroleum Institute
APPS .... Act to Prevent Pollution from Ships
AQRP .... Air Quality Regulatory Program
ARBO...................... Arctic Region Biological Opinion
ARRT .... Alaska Regional Response Team
ASAMM.................. Aerial Surveys of Arctic Marine Mammals
ASL .... above sea level
ASRC .... Arctic Slope Regional Corporation
ASWG .... Alaska Shorebird Working Group
atm........................... atmosphere (of air pressure)

AVALON/MERLIN Integration of Avalon Nodal Analysis program and Merlin Oil and Gas Reservoir Simulator
AWC........................Anadromous Waters Catalog of Alaska
AWI.........................Wainwright Airport
B.P. ....Before Present
BACT ....Best Available Control Technology
Bbbl ....Billion barrels of oil
bbls/d ....barrels of oil per day
bbl............................barrel=42 U.S. gallons
BC............................Black Carbon
BCB ....Bering-Chukchi-Beaufort Seas Stock of Bowhead Whales
Bcf...........................billion cubic feet
Bcfg ....billion cubic feet of gas
BE............................Biological Evaluation
BH ....Bowhead whale
BLM ....Bureau of Land Management
BO ....Biological Opinion
BOEMRE ....Bureau of Ocean Energy Management, Regulation, and Enforcement
BOEM ....Bureau of Ocean Energy Management
BOP ....Blowout Preventer (System)
BOWFEST ....Bowhead Whale Feeding Ecology Study
BP ....British Petroleum
B.P. ....Before Present
BPXA ....British Petroleum Exploration (Alaska)
BS ....Boundary segment(s)
BSEE ....Bureau of Safety and Environmental Enforcement
CAA.........................Clean Air Act or Conflict Avoidance Agreement
CAAA......................Clean Air Act Amendments (1990)
CAB.........................Chemical and Benthos
CAH.........................Central Arctic (Caribou) Herd
$CaCO_3$......................calcium carbonate
CAVM.....................Circumpolar Arctic Vegetation Map
CAVMT...................Circumpolar Arctic Vegetation Mapping Team
CBD.........................Center for Biological Diversity
CBMP......................Circumpolar Biodiversity Monitoring Program (Arctic Council's)
CBS ....Chukchi/Bering Seas Stock of Polar Bears
CD ....Consistency Determination under CZMA
CDC.........................Centers for Disease Control
CEQ.........................Council on Environmental Quality
CER ....Categorical Exclusion Review
CFCs........................chlorofluorocarbons
CFR ....Code of Federal Regulations
CH_4..........................methane
CHAOZ ....Chukchi Acoustic Oceanography and Zooplankton (program)
CI.............................Confidence Interval
CIAP........................Coastal Impact Assistance Program
CIP...........................Capital Improvement Program
C/N ....carbon/nitrogen ratio
CO ....carbon monoxide
CO_2..........................carbon dioxide
$CO_3{-}^2$.......................carbonate ion
COMIDA.................Chukchi Sea Offshore Monitoring in Drilling Area
Court of Appeals......United States Court of Appeals for the Ninth Circuit
cp ....centipoise (Measure of Viscosity)
CPAI........................Conoco-Phillips Alaska Incorporated [2x in 5]
CWA........................Clean Water Act

CZARA .... Coastal Zone Act Reauthorization Amendments of 1990
CZM .... Coastal Zone Management
CZMA .... Coastal Zone Management Act
dB .... decibels
DBO .... Distributed Biological Observatory
DEW........................ Distant Early Warning (system)
District Court........... United States District Court for the District of Alaska
DO .... Dissolved Oxygen
DPP.......................... Development and Production Plan
DPS.......................... Distinct Population Segment
Draft EIS .... Draft Environmental Impact Statement
Draft SEIS .... Draft Supplemental Environmental Impact Statement
DWH .... Deepwater Horizon
EA............................ Environmental Assessment
EEZ.......................... Exclusive Economic Zone
EFH .... Essential Fish Habitat
EIS .... Environmental Impact Statement
EJ .... Environmental Justice
EO............................ Executive Order
EP .... Exploration Plan
EPA .... [U.S.] Environmental Protection Agency
EPS .... Eastern Pacific Stock
ERA .... Environmental Resource Area
ESA .... Endangered Species Act
ESI .... Environmental Sensitivity Index
ESP .... Environmental Studies Program
EVOS .... Exxon Valdez oil spill
EWC .... Eskimo Walrus Commission
FEIS......................... Final Environmental Impact Statement
FHWG .... Fisheries Hydroacoustic Working Group
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......................... U.S. Fish and Wildlife Service
GBS .... gravity-based structure
G&G .... Geological and Geophysical
GHG .... Greenhouse gases
g/m^3 .... grams per cubic meter
g/min........................ grams per minute
GLS .... Grouped Land Segments
GOM........................ Gulf of Mexico
GW .... Gray Whale
ha .... hectares
HAP .... Hazardous Air Pollutant
H_2S .... hydrogen sulfide
HCs.......................... hydrocarbons
HOR .... heavy oil residue
HSWUA .... Hanna Shoal Walrus Use Area
Hz .... Hertz
IAP .... Integrated Activity Plan
IAPRC .... Interagency Arctic Research Policy Committee
ICAS........................ Inupiat Community of the Arctic Slope
ID............................. identification number

IFR........................... Interim Final Rule
IHA.......................... Incidental Harassment Authorization
IMO .... International Maritime Organization
INC .... Incident of Non-Compliance
IPCC .... Intergovernmental Panel on Climate Change
IPF .... Impact-Producing Factor
ISB........................... *in-situ* burn
ISC........................... Ice Seal Committee
ISER .... Institute for Social and Economic Research
ITA .... Incidental Take Authorization
ITL........................... Information to Lessees (Clauses)
ITR........................... Incidental Take Regulation
IUCN .... International Union for Conservation of Nature
IWC .... International Whaling Commission
JIT............................ Joint Investigation Team
kn .... knots
LA............................ Launch Area
LBCHU .... Ledyard Bay Critical Habitat Unit
Lease Sale 193 .... Chukchi Sea OCS Oil and Gas Lease Sale 193
LGM .... last glacial maximum
LNG......................... liquefied natural gas
LOA......................... Letter of Authorization
LOWC .... loss of well control
LPG .... liquid petroleum gas
LS .... Land Segment
LTO .... landing and takeoff cycle
M .... million
MAIs........................ Maximum Allowable Increases
MARPOL .... International Convention for the Prevention of Pollution from Ships
Mbbl .... thousand barrels
MBTA .... Migratory Bird Treaty Act
MC........................... mesoscale cyclones
Mcf .... thousand cubic feet
Mcf/d .... thousand cubic feet per day
Mcfg .... thousand cubic feet of gas
md .... millidarcy (measure of permeability)
mg/g......................... milligrams per gram
MMbbl..................... 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
MOA........................ Memorandum of Agreement
MODU..................... Mobile Offshore Drilling Unit
MOU........................ Memorandum of Understanding
MOR........................ moderate oil residue
MOVES .... Motor Vehicle Emissions Simulator
mph.......................... miles per hour
m/s .... meters per second
m^3/s .... cubic meters per second
MWCS..................... Marine Well Containment System
NAAQS .... National Ambient Air Quality Standards
NABC...................... Northwest Arctic Borough Code
NAE......................... National Academy of Engineering
NAO .... North Atlantic Oscillation

NASA .... National Aeronautic and Space Administration
NEPA .... National Environmental Policy Act
NGL......................... natural gas liquids
NGO .... non-governmental organization
NH_{4+} .... ammonium ion
NHPA .... National Historic Preservation Act
NHRP .... U.S. National Register of Historic Places
NISA........................ National Invasive Species Act of 1996
NMFS .... National Marine Fisheries Service
nmi.......................... nautical mile
NO .... nitric oxide
N_2O......................... nitrous oxide
NO_2......................... nitrogen dioxide
NO_3......................... nitrate ion
NOAA .... National Oceanographic and Atmospheric Administration
NOI......................... Notice of Intent
NOx .... nitrogen oxides
NPDES .... National Pollutant Discharge Elimination System
NPFMC .... North Pacific Fisheries Management Council
NPR-A .... National Petroleum Reserve in Alaska
NPS......................... National Park Service
NRC......................... National Research Council or National Response Center
NRDA...................... Natural Resource Damage Assessment
NRHP .... National Register of Historic Places
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
NWAB..................... Northwest Arctic Borough
O_3............................ Ozone
OCRM .... Ocean and Coastal Resource Management
OCS .... Outer Continental Shelf
OCSLA.................... Outer Continental Shelf Lands Act
OGP......................... (International Association of) Oil and Gas Producers
ONRR...................... Office of Natural Resource Revenue
OPA/OPA-90........... Oil Pollution Act of 1990
OPD......................... Official Protraction Diagram
OSC .... On-Scene Coordinator
OSFR....................... Oil Spill Financial Responsibility
OSRA .... Oil Spill Risk Analysis
OSHA .... Occupational Safety and Health Administration
OSR .... Oil-Spill Response
OSRP....................... Oil Spill Response Plan
OWM....................... Oil Weathering Model
PAC .... Pacific OCS Region
PACs........................ poly aromatic compounds
PAH......................... polycyclic aromatic hydrocarbons
PAME...................... Protection of the Arctic Marine Environment
Pb............................ lead
PBR .... Potential Biological Removal
PCB .... polychlorinated biphenyl
PDO......................... Pacific Decadal Oscillation
PEA .... Programmatic Environmental Assessment
PEIS......................... Programmatic Environmental Impact Statement

PEL .... Permissible Exposure Limit
PL .... pipeline segment
PM .... particulate matter
$PM_{2.5}$ .... Fine particulate matter with an aerodynamic diameter of 2.5 micrometers or less
PM_{10} .... Coarse particulate matter with an aerodynamic diameter of 10 micrometers or less
PMC .... polar mesoscale cyclone
PO_4 .... phosphate ion
ppb .... parts per billion
ppbv .... Parts per billion by volume
ppmv .... parts per million by volume
PSD .... Prevention of Significant Deterioration
psi .... pounds per square inch
PSO .... Protected Species Observer
psu .... practical salinity unit
PTS .... Permanent Threshold Shift
RCRA .... Resource Conservation and Recovery Act
RD .... Regional Director
RHA .... Rivers and Harbors Act
Rms .... root mean squared
ROD .... Record of Decision
ROI .... Record of Increase
ROMS .... Regional Ocean Modeling System
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
RUSALCA .... Russian-American Long-term Census of the Arctic
SAR .... search and rescue
SAON .... Sustaining Arctic Observing Network
SBS .... Southern Beaufort Sea Stock Of Polar Bears
Scenario .... Exploration, development, production and decommissioning scenario for Lease Sale 193
scf .... standard cubic Ffoot
SCR .... selective catalytic reduction
SDH .... Social Determinants of Health
Secretary .... Secretary of the Interior
SEIS .... Supplemental Environmental Impact Statement
SEL .... Sound Exposure Level
SEMS .... Safety and Environmental Management Systems
SHPO .... State Historic Preservation Officer
SIP .... State Implementation Plan
SL .... Significance Level (in air quality standards)
SLA .... Submerged Lands Act
SLS .... spring lead system
SNAPs .... Snap Shots of State Population Data
SO_2 .... sulfur dioxide
SO_4 .... sulfate ion
SO_x .... sulfur oxides
SFF .... Summer Fall Feeding
SSO .... sub-surface oil
SSOR .... sub-surface oil residue
stb .... Stock-Tank Or Standard Barrel
SUA .... Subsistence Use Area
Sv .... Sverdrups
TAGA .... Trace Atmospheric Gas Analyzer
TAPS .... Trans-Alaska Pipeline System

Tcf .... trillion cubic feet
Tcfg .... trillion cubic feet of gas
TCH .... Teshekpuk Lake Caribou Herd
TEK .... Traditional Environmental Knowledge
TLV .... Threshold Limit Value
TOC .... Total Organic Carbon
TSLA .... Teshakpuk Lake Special Management Area
TSP .... total suspended particles
TTS .... Temporary Threshold Shift
UAF .... University of Alaska, Fairbanks
UD .... Utilization Distribution
UERR .... Undiscovered Economically Recoverable Resources
ULSD .... ultra-low sulfur diesel fuel
UME .... Unusual Mortality Event
UNFCC .... United Nations Framework Convention on Climate Change
USACE .... U.S. Army Corps of Engineers
USC .... United States Code
USCG .... United States Coast Guard
USDOC .... U.S. Department of Commerce
USDOI .... U.S. Department of the Interior
USEPA .... U.S. Environmental Protection Agency
USFWS .... U.S. Fish and Wildlife Service
USFDA .... U.S. Food and Drug Administration
USGS .... U.S. Geological Survey
UTRR .... Undiscovered Technically Recoverable Resources
UV .... ultraviolet
VGP .... Vessel General Permit
VLOS .... Very Large Oil Spill
VOC .... Volatile Organic Compounds
VSM .... Vertical Support Member (Supports above-ground oil and gas pipelines)
WAH .... Western Arctic (Caribou) Herd
WCD .... Worst Case Discharge
WHO .... World Health Organization
WPS .... Western Pacific Stock

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Executive Summary

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EXECUTIVE SUMMARY

Background

The Bureau of Ocean Energy Management (BOEM) initiated this Second Supplemental Environmental Impact Statement (Second SEIS) process to address a deficiency identified by the U.S. Court of Appeals for the Ninth Circuit (Court of Appeals), and to inform the Secretary of the Interior's forthcoming decision to affirm, modify, or vacate Chukchi Sea OCS Oil and Gas Lease Sale 193 (Lease Sale 193).

The following is an abbreviated chronological discussion of the key actions leading to this Second SEIS process. These actions are attributed to BOEM or its predecessor agencies – the Minerals Management Service (MMS) and the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) – as appropriate.

- **June 2007:** MMS released the "Final Environmental Impact Statement for Oil and Gas Lease Sale 193 and Seismic-Surveying Activities in the Chukchi Sea" (2007 FEIS).
- **January 2008:** MMS issued the Final Notice of Sale for Chukchi Sea OCS Oil and Gas Lease Sale 193.
- **January 31, 2008:** A lawsuit was filed alleging violations related to the National Environmental Policy Act (NEPA) and the Endangered Species Act (ESA).
- **February 2008:** Lease Sale 193 was held, and MMS received high bids totaling approximately $2.7 billion and issued 487 leases, covering approximately 2.8 million acres.
- **July 21, 2010:** The U.S. District Court for the District of Alaska (District Court) issued an Order remanding the Lease Sale 193 decision to BOEMRE to remedy three NEPA-related concerns.
- **August 18, 2011:** BOEMRE released the "Final Supplemental Environmental Impact Statement for Oil and Gas Lease Sale 193 in the Chukchi Sea" (2011 SEIS).
- **October 3, 2011:** The Secretary issued a Record of Decision that selected Alternative IV (Corridor II Deferral) and thus affirmed Lease Sale 193 as it was originally held in February 2008.
- **February 2012:** The District Court found that BOEM had satisfied its NEPA obligations on remand and dismissed the Plaintiff's petition.
- **April 2012:** Plaintiffs appealed the District Court's decision to the Court of Appeals, raising two issues: (1) whether the 2011 SEIS properly took account of incomplete or unavailable information; and (2) whether the 2007 FEIS and 2011 SEIS' reliance on a one billion barrel estimate of oil produced as a result of Lease Sale 193 was arbitrary and capricious.
- **January 22, 2014:** The Court of Appeals issued a published opinion concluding that the 2011 SEIS properly took account of incomplete or unavailable information, but that reliance on a one billion barrel production estimate was arbitrary and capricious. The Court of Appeals remanded the matter to the District Court for further proceedings consistent with its opinion.
- **April 24, 2014:** The District Court remanded the matter back to BOEM for further analysis consistent with the Court of Appeals' decision.
- **June 20, 2014:** BOEM issued the Notice of Intent to prepare the Second SEIS.
- **October 31, 2014:** BOEM released the "Draft Second Supplemental Environmental Impact Statement for Oil and Gas Lease Sale 193."

- **November-December 2014:** BOEM administered a 45-day public comment period and received more than 430,000 comments. BOEM also held public hearings and government-to-government consultations with affected federally recognized tribes.

Regulatory and Administrative Framework

The framework of the Federal Outer Continental Shelf (OCS) oil and gas leasing process is established by the Outer Continental Shelf Lands Act (OCSLA). The OCSLA requires the U.S. Department of the Interior (USDOI) to manage the orderly leasing, exploration, development, and production of oil and gas resources on the Federal OCS, while simultaneously ensuring the protection of the human, marine, and coastal environments; and the public receives a fair and equitable return for these resources. The USDOI has delegated many of its responsibilities concerning OCS oil and gas leasing to BOEM. In discharging these duties, the USDOI, and by extension BOEM, must also comply with NEPA, which requires the integrated use of natural and social sciences in any Federal agency planning and decision making processes. More specifically, NEPA requires Federal agencies to prepare a detailed Environmental Impact Statement (EIS) on major Federal actions significantly affecting the quality to the human environment. Other laws, regulations, and Executive Orders are also applicable to OCS activities.

1. THE PROPOSED ACTION AND ALTERNATIVES

This Second SEIS retains the alternatives analyzed in the 2007 FEIS and the 2011 SEIS. Below are descriptions of the four alternatives and their consequences with respect to the Secretary's forthcoming decision to affirm, modify, or vacate Lease Sale 193. No additional areas will be offered for lease under any alternative.

1.1. Alternative I (Proposed Action)

Alternative I entailed offering the entire Chukchi Sea Program Area for leasing. This area consisted of approximately 34 million acres within the Chukchi Sea. Specifically excluded from this alternative was the 25 Statute Mile (40 km) Buffer implemented by the Secretary in the Final OCS Oil and Gas Leasing Program for 2007–2012.

Lease Sale 193 has already occurred. All of the leases originally issued are contained in the area covered by Alternative I. Accordingly, selecting Alternative I based on this Second SEIS process would result in affirming Lease Sale 193 and all of the leases.

1.2. Alternative II (No Action)

Alternative II, which is the "No Action" Alternative, entailed offering no areas in the Chukchi Sea Program Area for leasing.

Lease Sale 193 has already occurred. Selecting Alternative II based on this Second SEIS process would result in not affirming the lease sale and vacating the leases.

1.3. Alternative III (Corridor I Deferral)

Alternative III entailed offering the entire Chukchi Sea Program Area for leasing, minus a corridor (referred to as Corridor I) extending 60 miles (97 km) offshore along the coastward edge of the Program Area to protect important bowhead whale habitat. The area for leasing under this Alternative consisted of approximately 24 million acres in the Chukchi Sea.

Lease Sale 193 has already occurred. Five existing leases are contained within Corridor I. Accordingly, selecting Alternative III based on this Second SEIS process would result in affirming the lease sale, except the area in the Corridor I. As a result, all of the leases would be affirmed, except the five within Corridor I, which would be vacated.

1.4. Alternative IV (Corridor II Deferral)

Alternative IV entailed offering the entire Chukchi Sea Program Area for leasing, minus a corridor (referred to as Corridor II) along the coastward edge of the Program Area. The area covered by Corridor II was a subset of the area covered by Corridor I. The area for leasing under this Alternative consisted of 29.4 million acres. In February 2008, USDOI offered for lease the area covered by Alternative IV in Lease Sale 193.

All leases are contained in the area covered by this alternative. Accordingly, selecting Alternative IV as a result of this Second SEIS process would result in affirming the lease sale and all of the leases.

1.5. Preferred Alternative

BOEM's preferred alternative is Alternative IV. The 2007 FEIS for the Outer Continental Shelf Oil & Gas Leasing Program 2007-2012 stated a preferred alternative that took into consideration the reasonable balance between the development of available hydrocarbon resources and the protection of the environment by excluding development in the most environmentally sensitive areas. The Final 2007-2012 OCS Oil and Gas Leasing Program adopted this preferred alternative by not offering for lease the OCS blocks within 25 miles of the shore in the Chukchi Sea Planning Area in Lease Sale 193. Through further analysis of Lease Sale 193, Alternative IV was identified in the 2007 FEIS and the 2011 Final SEIS which included mitigating measures as the agency's preferred alternative. Alternative IV remains BOEM's preferred alternative in this Final Second SEIS because it continues to represent a reasonable balance between environmental, economic, and technical considerations, as mandated by the OCSLA. No new information or analysis within the Draft Second SEIS tips the reasonable balance towards another alternative in this Final Second SEIS.

1.6. Updated Scenario

Scenarios are conceptual views of the future and represent possible, though not necessarily probable, sets of activities. BOEM created an exploration, development, production, and decommissioning scenario (Scenario) for Lease Sale 193 to provide a basis for an environmental effects analysis in this Second SEIS. The Scenario assumes the discovery and development of two prospects and represents a "high case" of oil and gas activities that could result from Lease Sale 193 and subsequent Exploration Plans and Development and Production Plans.

Both prospects are assumed to contain both oil and natural gas. The Scenario assumes that oil would be produced first, and that natural gas would be reinjected until the economically-recoverable oil is depleted, at which point operators would switch to producing natural gas for sale. Both the oil and the natural gas would be transported to market via pipelines. The combined oil and condensate assumed to be produced from the two fields is 4.3 Bbbl. The combined natural gas produced is 2.2 Tcf. Producing this volume of oil and gas would require eight platforms of a new Arctic-class design and drilling 589 wells (exploration, delineation, production, and service). The time from exploration to final production and decommissioning is 77 years.

2. DESCRIPTION OF THE ENVIRONMENT

The description of the physical, biological, and socioeconomic conditions within and adjacent to the Leased Area is summarized below.

2.1. Physical Environment

The Leased Area is located on the relatively shallow continental shelf of 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. 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 these areas 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. Analysis of long-term data indicates substantial reductions in both extent and thickness of Arctic sea-ice cover during the past 20-40 years. There are three general forms of sea ice in the Chukchi Sea: landfast ice, stamukhi ice, and pack ice. Biologically important polynyas (large areas of open water surrounded by ice) 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 Leased Area and adjacent areas.

2.2. 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 present here. Essential Fish Habitat (EFH) has been designated for all five species of Pacific salmon as well as for Arctic cod, saffron cod, and opilio crab. An abundance of marine mammals use the Chukchi Sea, most notably the bowhead and beluga whales, polar bears, Pacific walrus, and ice seals. Several species are listed as Endangered or Threatened or classified as 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 species. Onshore, caribou and other terrestrial mammals inhabit the predominately tundra and wetland environment.

2.3. Socioeconomic Environment

The coastline adjacent to the Leased 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 (NSB), 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 may also be present in and around the Leased Area.

3. ENVIRONMENTAL CONSEQUENCES

This section analyzes the potential direct and indirect environmental impacts that could result from Lease Sale 193. The basis of this analysis is the Scenario described previously. For the purpose of analysis, all of the oil and gas exploration, development, production and decommissioning activities described in the Scenario are assumed to occur as a result of the Proposed Action, Alternative III, and Alternative IV. Potential impacts to environmental resource categories are summarized in Table ES-1, below.

Table ES-1. Potential Impacts Resulting from the Hypothetical Exploration and Development Scenario[1].

Resource	Effects of Alternative
	Alternatives I and IV Proposed Action (no deferral area) and Corridor II (smaller deferral area)
Water Quality	Considering all effects on water resources from all activities in Years 1-77, the impacts would be moderate due to two large oil spills, various permitted discharges from all activities over all years, and the potential effects of introduced aquatic invasive species.
Air Quality	Each stage of operation within each phase of the Scenario results in a negligible air quality impact when considering the countervailing effects of actual operations together with dilution and diffusion of the pollutants over time and distance. The emission sources, when characterized as mobile, will not produce emissions sufficient to overwhelm the effects of wind and transport in a single area causing deterioration of air quality over the Alaska North Slope. The overall analysis of air quality demonstrates a negligible impact on the Alaska North Slope, except in the case of a large oil spill, in which case the impact would be moderate because of VOC emissions that would be long lasting and widespread, but less than severe.

Resource	Effects of Alternative
Climate Change	The exploration, development, production, and decommissioning activities under the Scenario would produce greenhouse gas (GHG) emissions and particulate matter (PM) that would contribute to climate change. The GHG and PM emissions from the Scenario would be small relative to global GHG and PM emissions, and therefore, the contribution of the Scenario to global climate change would be negligible.
Lower Trophic Organisms	The impacts of all routine activities in the Scenario on lower trophic level organisms are expected to be moderate over the life of the Scenario. This is due to the resiliency and reproductive capability of the organisms. The potential impacts from large spills are expected to be moderate due to the persistence of oil in tidal and sub-tidal sediments.
Fish	Considering all time periods (Years 1-77) and all types of effects from the activities during these time periods (including two large oil spills between Years 10-74), the impacts on fish from routine oil and gas activities from the Scenario would be minor. Although mortality of individuals would occur, and there could be potential introduction of invasive species, the effects on fish would be localized and short-term. In the event of a large oil spill, effects would be moderate because they would be widespread, long-lasting, mortality of individuals would occur, and there would be potential for introduction of invasive species.
Marine and Coastal Birds	The potential level of mortality to marine and coastal birds, combined with habitat loss and long-term disturbances from pipeline corridor maintenance from the Scenario over the life of the Scenario are anticipated to result in a major impacts on marine and coastal birds. The impacts are expected to have long-lasting changes in the resource's function in the ecosystem.
Marine Mammals	The impacts of the Scenario on marine mammals are expected to range from negligible to moderate for all routine activities associated with the Scenario, depending on the species, nature and timing of activities. The potential impacts from large oil spills could range from negligible to major.
Terrestrial Mammals	The impacts of routine activities in the Scenario on terrestrial mammals such as caribou and muskox would be moderate due to disturbance from noise, vehicle and human presence, and other activities. The impacts of potential large oil spills in the Chukchi Sea on terrestrial mammals would be negligible to minor.
Vegetation and Wetlands	The impacts of routine activities in the Scenario on vegetation and wetlands are expected to range from negligible to minor, due to short-term, localized effects on ecological functions, species abundance and composition of wetlands and plant communities. The potential impacts from large oil spills would range from minor to moderate, depending the location and effectiveness of response measures.
Economy	The impacts of the Scenario on the economy are expected to be major, as the Scenario would cause long-lasting and widespread increases in employment and labor income over many years.
Subsistence-Harvest Patterns	The impacts of the Scenario on subsistence-harvest patterns are expected to range from minor to major at various times over the course of the 77-year Scenario. This is due to disruptions in subsistence hunting from degradation of subsistence resources and use areas. Actual or perceived tainting from potential large oil spills could render resources unavailable or undesirable for use, which would result in a major impact.
Sociocultural Systems	The impacts of the Scenario on sociocultural systems could be up to major depending on the phase of the activity. When subsistence harvest patterns are adversely affected, sociocultural systems can in turn be impacted. Subsistence harvest patterns can be disrupted from routine activities during the Scenario or large oil spills.
Public and Community Health	The impacts of the Scenario on public and community health could range from negligible to major depending on the phase and nature of the activity, and would have both beneficial and adverse impacts. These impacts are closely related to impacts on subsistence harvest patterns and sociocultural systems.
Environmental Justice (EJ)	Anticipated effects from the Scenario to EJ would be up to major, depending on the phase and nature of the activities. The phases with the most overlapping activities and highest probability of spills would cause the most impact to subsistence-harvest patterns and thus the highest level of EJ impacts.
Archaeological Resources	Anticipated impacts to historic and prehistoric archaeological resources from the Scenario would be major, given that historic and archaeological resources would be present, difficult to identify, and directly affected by activities described in this section. Impacts would be major for both routine activities and large spills. The amount of ground disturbance, both on- and offshore, would be of a large magnitude and a long duration. This impact assessment is not altered in the event of a 5,500 or 1,700 bbl oil spill.

Resource	Effects of Alternative
	Alternatives II and III **No Action and Corridor I (larger deferral area)**
Alternative II No Action	Under the No Action Alternative (Alternative II), the Secretary would decline to affirm Lease Sale 193, and would instead vacate the leases. Selection of this alternative would effectively eliminate the possibility for OCS oil and gas development and production as a result of Lease Sale 193. Potential environmental impacts to the marine, coastal, and human environments from OCS development and production would not occur. 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 (lease rents, taxes, royalties on production) would not be realized from Lease Sale 193. 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 nation, and 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.
Alternative III Corridor I (larger deferral area)	The effects of Alternative III are based on the application of the same Scenario as analyzed under Alternatives I and IV. Using the Impacts Scale in Section 4.2, the level of expected impacts under Alternative III are consistent with the levels of expected impacts described under Alternative I. Nevertheless, the larger deferral area could result in differences in some impacts between Alternatives III and Alternatives I and IV due to the greater distance of many Scenario activities from shore, subsistence areas and important environmental resource areas. The removal of certain areas from leasing could also affect conditional probabilities of a hypothetical oil spill contacting shore and other important resource areas.

Notes: [1]For each environmental resource category, types and levels of potential impacts are described for Alternatives I and IV. A general discussion of impacts associated with Alternatives II and III is then provided for comparison.

3.1. Very Large Oil Spill Scenario (VLOS) and Effects

The potential effects of a low-probability, high impacts event—a Very Large Oil Spill (VLOS)—were also analyzed in this Second SEIS. In the unlikely event that a VLOS were to occur in the Chukchi Sea, the potential for significant effects on a variety of resource categories would be high. Significant adverse impacts could potentially occur (to components or species) within all examined environmental resource categories.

4. CUMULATIVE EFFECTS

This section analyzes the potential cumulative effects of the Proposed Action. Cumulative effects are assessed by determining the incremental impact of an action when added to the impacts of past, present, and reasonably foreseeable future actions in the vicinity of the project. Actions considered include other oil and gas activities, community development, recreation and tourism, marine vessel traffic, aircraft traffic, subsistence activities, research and survey activities, mining projects, and military/Homeland Security activities. The analysis also considers climate change and its ongoing role in the changing Arctic ecosystem. Potential cumulative effects for each resource category are summarized in Table ES-2, below.

Table ES-2. Potential Cumulative Effects[1].

Resource	Effects of Alternatives
	Alternative I and Alternative IV **Proposed Action (no deferral area) and Corridor II (smaller deferral area)**
Water Quality	Water quality impacts from activities associated with Alternatives I and IV, together with other past, present, and reasonably foreseeable future actions would have the potential to cause major impacts to both onshore and offshore water quality.
Air Quality	Air quality impacts from activities associated with Alternatives I and IV, together with other past, present, and reasonably foreseeable future actions and emissions from those actions, would not have the potential to cause major effects, and would have a negligible level of cumulative effects to onshore air quality.
Lower Trophic Organisms	The cumulative impacts on lower trophic levels tend to be localized to areas near the activity, and so are geographically dispersed. Therefore, the overall impact from the Proposed Action and past, present, and reasonably foreseeable future actions is minor.
Fish	The effects of Alternatives I and IV when added to past, present and reasonably foreseeable future actions would result in a major level of impact. The primary driver may not be the action alternatives but rather changes associated with climate change and loss of sea ice.

Resource	Effects of Alternatives
Marine and Coastal Birds	The effects of Alternatives I and IV, when added to past, present and reasonably foreseeable future actions, would result in a major level of impact to marine and coastal birds. The action alternatives would be the primary driver of effects to this resource over the life of the Scenario, particularly to spectacled eiders, king and common eiders, and seabirds, including the short-tailed shearwater, and common and thick-billed murres.
Marine Mammals	The cumulative effects of Alternatives I and IV when added to past, present and reasonably foreseeable future actions on marine mammals would range from negligible to major. The primary driver of these effects is not the action alternatives but rather the anticipated effects of climate change.
Terrestrial Mammals	The contribution of Alternatives I and IV to the effects on terrestrial mammals ranges from negligible to minor. When added to past, present and reasonably foreseeable future actions the cumulative impacts would be minor except for caribou. Major impacts to caribou are anticipated as a result of climate change.
Vegetation and Wetlands	While the cumulative impacts from Alternatives I and IV and other past, present, and reasonably foreseeable actions are additive, the total amount of disturbance area is small compared to the total amount of wetlands on the Arctic Coastal Plain. However, it is anticipated that the environmental changes associated with Arctic climate change would, in the long run, have the greatest potential to impact vegetation and wetlands on the North Slope.
Economy	The overall impact from Alternatives I and IV on economic development when added to the past, present, and reasonably foreseeable future actions described in Chapter 5 would be large because of the substantial increase in economic activity.
Subsistence-Harvest Patterns	The effects of past, present, and reasonably foreseeable future actions when combined with Alternatives I and IV on subsistence harvests range from minor to major, depending upon the external driver. In the case of climate change, adverse effects on subsistence resources have been and continue to be uncontrolled.
Sociocultural Systems	The overall cumulative impact on local and regional sociocultural patterns for Alternatives I and IV would be major. Growth of tax revenue on the North Slope, with corresponding growth in the capital budget and provision of government services, would provide substantial local benefit; however, dramatic cumulative changes in sociocultural systems would likely occur at a major level of effect.
Public and Community Health	The overall cumulative impact on local and regional subsistence-harvest and sociocultural patterns as a result of Alternatives I and IV when added to other past, present, and reasonably foreseeable future actions would be major; therefore the overall cumulative effect to public health would also be major due to changes in nutrition and social conditions. Growth of tax revenue on the North Slope, with corresponding growth in the capital budget and provision of government services would provide substantial local public health benefit as infrastructure such as medical facilities and schools are built. Since much of the large-scale infrastructural changes anticipated would be substantially facilitated or accelerated by Alternatives I and IV, the incremental contribution to the cumulative effect on public health would also be major.
Environmental Justice	Potential impacts on human health from long-term, cumulative effects impacting traditional culture, and community infrastructure of subsistence-based indigenous communities in the North Slope Borough and Northwest Arctic Borough are expected. Potential disproportionately high adverse effects on low-income, minority populations in the region are expected to be mitigated substantially but not eliminated.
Archaeological Resources	The cumulative effects of Alternatives I and IV on historic and archaeological resources would range from negligible to major, depending upon the driver. The overall effect of knowledge gained from site identification during the planning stages would contribute in a major way toward unlocking the secrets of the past. With the safeguards already in place through National Historic Preservation Act and the Federal permitting process, Alternatives I and IV are unlikely to produce harmful incremental effects on archaeological and historical sites, and cumulative effects may be negligible if mitigation measures described herein are applied.
Alternatives II and III No Action and Corridor I (larger deferral area)	
Alternative II No Action	Under the No Action Alternative, the Secretary would not affirm Lease Sale 193, and would instead vacate the leases. Selection of this alternative would effectively eliminate the possibility for OCS oil and gas development and production as a result of Lease Sale 193. Potential environmental impacts to the marine, coastal, and human environment from OCS development and production would not occur and therefore there would be no additional impacts to combine with impacts from past, present and reasonably foreseeable future activities.
Alternative III Corridor I (larger deferral area)	The effects of Alternative III are based on the application of the same Scenario as analyzed under Alternatives I and IV. The anticipated cumulative impacts of Alternative III are similar to those described for Alternatives I and IV. However, the larger deferral area could result in differences in some impacts due to the greater distance of many Scenario activities from shore, subsistence areas and important environmental resource areas. The effects of Alternative III, when added to past, present and reasonably foreseeable future actions would generally be less than those anticipated in Alternatives I and IV.

Notes: [1]Effects resulting from the hypothetical Exploration and Development Scenario and other past, present, and reasonably foreseeable future actions.

For each environmental resource category, types and levels of potential cumulative impacts are described for Alternatives I and IV. A general discussion of impacts associated with Alternatives II and III is then provided for comparison.

5. CONSULTATION AND COORDINATION

BOEM has engaged in several consultation and coordination processes with Federal regulatory agencies and federally recognized tribes regarding Lease Sale 193. Below is a brief summary of how BOEM has satisfied, or will satisfy, its consultation requirements with respect to Lease Sale 193:

Executive Order 13175 – Tribal Consultation. BOEM and its predecessor agencies have consulted with potentially affected tribal governments and ANCSA Corporations at multiple steps in the Lease Sale 193 process. BOEM engaged in another round of consultations with potentially affected tribes and ANCSA Corporations following release of the Draft Second SEIS.

Endangered Species Act – Section 7 Consultation. BOEM and its predecessor agencies have consulted with NMFS and USFWS multiple times during the Lease Sale 193 process. NMFS and USFWS have each issued Biological Opinions concluding that Lease Sale 193 is not likely to jeopardize the continued existence of ESA-listed species under their respective jurisdictions. BOEM has reinitiated Section 7 consultation with both NMFS and USFWS in light of the updated Scenario analyzed in this Second SEIS.

Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Consultation. In 2011 BOEMRE (now BOEM) consulted with the National Marine Fisheries Service (NMFS) regarding the potential effects on EFH for all five species of Pacific salmon as well as Arctic cod, saffron cod, and opilio crab. To address EFH consulation requirement sin light of the updated Scenario, BOEM will submit a separate EFH Assessment.

National Historic Preservation Act – Section 106 Consultation. Prior to Lease Sale 193, the Alaska State Historic Preservation Office concurred that proposed Lease Sale 193 would not affect historic resources. Additional project- and site-specific consultations would occur as needed for any proposed exploration, development, production, and decommissioning activities.

Coastal Zone Management Act – Consistency Review. Prior to Lease Sale 193, the State of Alaska issued a final consistency decision concurring with the determination that the proposed lease sale is consistent (to the maximum extent practicable) with the Alaska Coastal Management Program (ACMP) and the local district’s enforceable policies. The ACMP has since terminated and there are no longer any enforceable standards on which to base a consistency review.

6. APPENDICES

Appendix A. Accidental Oil Spills and Gas Releases

Appendix A discusses the technical information used to estimate numbers and volumes of oil spills and natural gas releases assumed to occur over the life of the Scenario. The rationale for these assumptions is a mixture of project-specific information, modeling results, statistical analysis, three decades of experience modelling hypothetical oil spills, and professional judgment.

Appendix B. Resource Assessment and Methodology

Appendix B explains the methodology used by BOEM to estimate the full range of production that could reasonably result from Lease Sale 193 and subsequent lease sales in the Chukchi Sea, and to determine a plausible distribution of that production among various geologic prospects. This methodology differs from a typical presale resource assessment in that it occurred after the lease sale in question and utilized actual bidding data from Lease Sale 193.

Appendix C. Protected Species Mitigation Measures

Appendix C discusses in greater detail the various mitigation measures which are expected to reduce potential impacts from the Proposed Action to protected species. These mitigation measures include

Lease Sale 193 Stipulations, typical mitigations measures incorporated into Marine Mammal Protection Act take authorizations, and typical mitigation measures incorporated into Biological Opinions issued pursuant to Section 7 of the ESA.

Appendix D. Guide to Lease Stipulations

Appendix D provides the Lease Stipulations applicable to Lease Sale 193. Also provided is explanation of how these stipulations are to be interpreted in light of reorganization of MMS into three independent agencies.

Appendix E. Responses to Public Comments

Appendix E summarizes and provides responses to comments received on the Draft Second SEIS. BOEM conducted a thorough review of oral testimony received at public hearings as well as electronic and written comments and issues raised during government-to-government consultations. All relevant, substantive comments are grouped within distinct issue categories. Within each issue category, specific topics are defined, comment sources are identified, and BOEM's response are provided.

Appendix F: Air Quality Analysis Methodology

Appendix F provides data which give details of assumptions and emission factors used in analyzing air quality effects throughout this Final Second SEIS.

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The Proposed Action

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CHAPTER 1. PROPOSED ACTION

1.1 Background

This chapter describes the Proposed Action, the Purpose and Need for the Proposed Action, and the larger context for preparing this Alaska Outer Continental Shelf (OCS), Chukchi Sea Planning Area Oil and Gas Lease Sale 193, Second Supplemental Environmental Impact Statement (Second SEIS).

On May 19, 2010, Secretarial Order No 3299 began a reorganization of the Minerals Management Service (MMS) and ordered establishment of the Office of Natural Resources Revenue (ONRR), Bureau of Ocean Energy Management (BOEM), and the Bureau of Safety and Environmental Enforcement (BSEE). On June 18, 2010, by Secretarial Order No. 3302, the U.S. Department of the Interior (USDOI), Minerals Management Service (MMS) was renamed the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE). On September 30, 2010, by Secretarial Order No. 3306, ONRR was established, and natural resource royalty and revenue collection responsibility was reassigned from BOEMRE to ONRR. Then, on October 1, 2011, BOEMRE was re-organized into two independent entities: the Bureau of Ocean Energy Management (BOEM), which is responsible for managing development of the nation's OCS resources in an environmentally and economically responsible way, and the Bureau of Safety and Environmental Enforcement (BSEE), which is responsible for enforcement of safety and environmental regulations.

The following is a chronological discussion of the key actions leading to this Second SEIS process. The actions are attributed to MMS, BOEMRE, or BOEM, as appropriate.

- June 30, 2002: The Secretary of the USDOI approved a Final OCS Oil and Gas Leasing Program for 2002–2007 (2002–2007 Five-Year Program).
- September, 2005: In compliance with the National Environmental Policy Act (NEPA), MMS published a Notice of Intent to Prepare an Environmental Impact Statement (EIS) analyzing a proposed lease sale known as the Chukchi Sea OCS Lease Sale 193.
- October 2006: MMS released the "Draft Environmental Impact Statement for Oil and Gas Lease Sale 193 and Seismic-Surveying Activities in the Chukchi Sea" (USDOI, MMS, 2006a).
- 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" (hereafter "2007 FEIS") (USDOI, MMS, 2007a). The 2007 FEIS is available on the BOEM website at http://www.boem.gov/ak193/.
- June 29, 2007: 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. The Chukchi Sea OCS Oil and Gas Lease Sale 193 was therefore included in the 2007-2012 Five Year OCS Oil and Gas Leasing Program approved by the Secretary on June 29, 2007.
- 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.
- January 31, 2008: A lawsuit was filed alleging violations pursuant to NEPA and the Endangered Species Act (ESA) (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.
- February 2008: Lease Sale 193 was held, and MMS received high bids totaling approximately $2.7 billion and issued 487 leases, covering approximately 2.8 million (M) acres (1.1M ha).

- 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 decision to BOEMRE to satisfy its obligations under NEPA in accordance with the District Court's opinion. Pursuant to an 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 2007 FEIS was essential or relevant under 40 Code of Federal Regulations (CFR) 1502.22.
  - Determine whether the cost of obtaining the missing information was exorbitant, or the means of doing so unknown.
- 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.
- 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.
- November 2010: BOEMRE held public hearings and government-to-government consultations with affected federally recognized 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).
- March 2011: BOEMRE announced its decision to incorporate an analysis of a Very Large Oil Spill (VLOS) event in its ongoing SEIS process.
- May 27, 2011: A Revised Draft SEIS was released to the public with a 45-day public comment period ending July 11, 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 government, tribal governments and Alaska Native organizations, State and local governments; tribes; corporations, nongovernmental entities, conservation groups, 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 Alaska Outer Continental Shelf, Chukchi Sea Planning Area Oil and Gas Lease Sale 193 Final Supplemental Environmental Impact Statement (hereafter "2011 SEIS") (USDOI, BOEMRE, 2011a), available at http://www.boem.gov/ak193/.
- August 18, 2011: BOEMRE released the 2011 SEIS on August 18, 2011.
- October 3, 2011: The Secretary issued a Record of Decision (ROD), which selected Alternative IV (Corridor II Deferral) and thus affirmed Lease Sale 193 as it was originally held in February 2008.
- February 2012: Finding that BOEM had satisfied its NEPA obligations on remand, the District Court granted BOEM's motion for summary judgment and dismissed the Plaintiff's petition.
- April 2012: Plaintiffs appealed the District Court's decision, raising two arguments: (1) whether the 2011 SEIS properly took account of incomplete or unavailable information; and (2) whether the 2007 FEIS and 2011 SEIS' reliance on a one billion barrel estimate of oil produced as a result of Lease Sale 193 was arbitrary and capricious.
- March 5, 2013: The U.S. Court of Appeals for the Ninth Circuit (Court of Appeals) heard oral argument.
- January 22, 2014: The Court of Appeals issued a published opinion concluding that the 2011 SEIS properly took account of incomplete or unavailable information, but that reliance on

a one billion barrel production estimate was arbitrary and capricious. The Court of Appeals remanded the matter to the District Court for further proceedings consistent with its opinion.

- April 24, 2014: The District Court remanded the matter back to BOEM for further analysis consistent with the Court of Appeals' decision.

BOEM then initiated this Second SEIS process to address the deficiency identified by the Court of Appeals in its remand to the District Court, and to inform the Secretary's forthcoming decision to affirm, modify, or vacate Lease Sale 193. In accordance with Council on Environmental Quality (CEQ) regulations and guidelines, BOEM also intends that further analysis of specific proposed activities may tier from the Second SEIS, such that the facts and analysis presented in the Second SEIS may be incorporated by reference into future proposed specific environmental reviews.

1.2 Purpose and Need for the Proposed Action

The purpose of the Proposed Action addressed in the 2007 FEIS, the 2011 SEIS, and this Second SEIS is to: (1) offer for lease / affirm leases in the Chukchi Sea Planning Area (see Figure 1-1) of the OCS that might contain economically recoverable oil and gas resources, and (2) provide analyses for exploration activities. This Second SEIS augments the 2007 FEIS and the 2011 SEIS by providing additional environmental analysis of potential exploration, development, production, and decommissioning activities from Lease Sale 193.

Figure 1-1. Sale 193 Program Area. *The Chukchi Sea Lease Sale 193 Program Area excluded OCS blocks within a 25-mile (mi) (40 km) 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 Outer Continental Shelf Lands Act of 1953 (OCSLA), as amended (43 USC 1331 et seq.), established Federal jurisdiction over submerged lands seaward of state boundaries. Under the OCSLA, the USDOI 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 receipt of fair market value for the lands leased and the rights conveyed by the Federal government. The OCSLA grants the Secretary the authority to issue 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 OCSLA. The Secretary has designated BOEM as the agency responsible for the mineral leasing of submerged OCS lands, in accordance with the provisions of the OCSLA.

The Chukchi Sea OCS is viewed as potentially one of the most petroleum-rich offshore areas in the country, with geologic plays extending offshore from some of the largest oil and gas fields on Alaska's North Slope. BOEM's current petroleum assessment for the entire Chukchi Sea OCS indicates a mean technically recoverable oil resource of 15.38 billion barrels (Bbbl) with a 5% chance of 40.08 Bbbl (USDOI, BOEMRE, 2011a). 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 OCS areas within the Chukchi Sea may lead to development and production, and could contribute significantly to the national energy supply.

1.3 Description of the Proposed Action

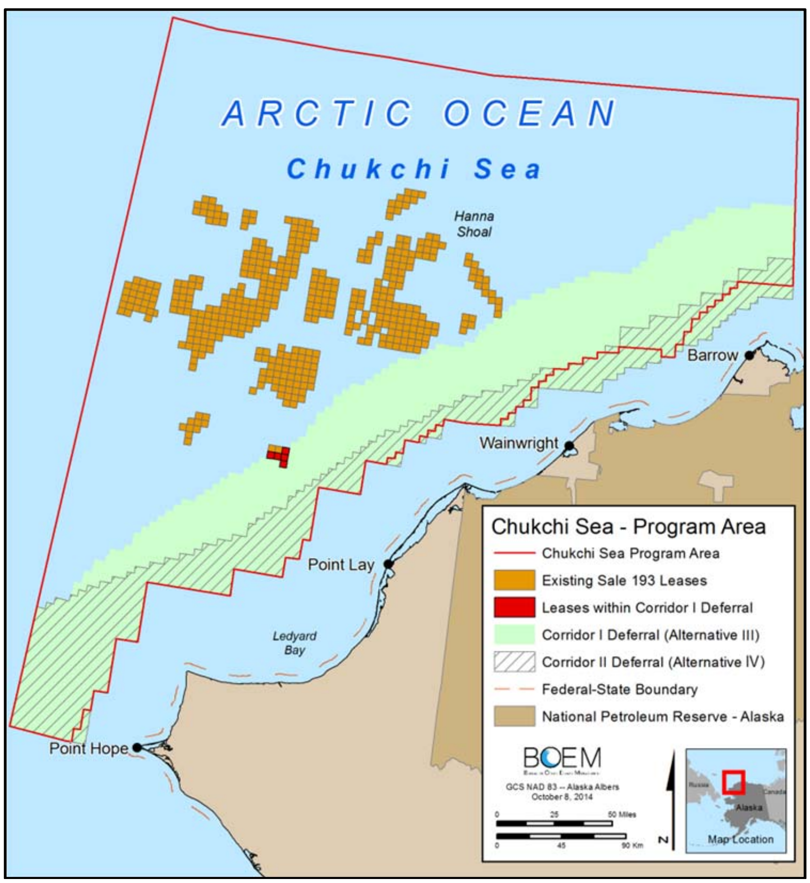

Figure 1-2. Sale 193 Leased Area. *The Chukchi Sea Program Area is illustrated with a red border—it excludes OCS blocks within a 25 mi (40 km) coastal buffer (deferred in the 2007–2012 Five-Year Program). Deferral Corridor I (Alternative III) and Deferral Corridor II (Alternative IV) are also illustrated, as well as the existing 460 leased blocks from Lease Sale 193.*

The Proposed Action is to affirm Lease Sale 193 and all of the leases issued as a result of the sale. These leases include 460 blocks (the Leased Area) in the Chukchi Sea Program Area (Figure 1-2). The Chukchi Sea Program Area comprises lease blocks within approximately 33 million acres (13.3M ha). This area excludes a 25 Statute Mile (40 km) shoreline buffer implemented by the Secretary in the final OCS Leasing Program for 2007-2012.

The Program Area is coextensive with the Area Identification used for environmental analysis in the 2007 FEIS. In 2008, the Final Notice of Sale and supporting information constituted the Secretary's decision on selecting Alternative IV, which included a deferral area along the coastal edge of the Program Area. As a result, approximately 29.4 million acres (11.9M hectares (ha)) were offered for sale in February 2008. As a result of the lease sale, MMS received high bids totaling approximately $2.7 billion and issued 487 leases, covering approximately 2.8 million acres (1.1M ha). Since 2008, 27 of the leases were relinquished; 460 active leases remain (Figure 1-2). Lease Sale 193 has already been held, and no additional leases will be issued as a result of this Second SEIS process.

1.4 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 government laws and regulations.

A complete treatment of the regulatory and administrative framework can be reviewed in the 2007-2012 Five-Year Program Environmental Impact Statement (EIS) (http://www.boem.gov/2007-2012-FEIS) and the 2012-2017 Five-Year Program EIS (http://www.boem.gov/2012-2017-FEIS-PDF/).

1.4.1. Outer Continental Shelf Lands Act (OCSLA)

Under OCSLA and the Code of Federal Regulations, the USDOI is required to manage the orderly leasing, exploration, development, production, and decommissioning of oil and gas resources on the Federal OCS, while simultaneously ensuring the following: the protection of the human, marine, and coastal environments; and assuring receipt of fair market value for the lands leased and the rights conveyed by the Federal government. The OCSLA also requires coordination with affected states, as well as local governments, affected by OCS development activities. BOEM 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 1-3). In the first stage, the Secretary (through BOEM) 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, BOEM conducts the prelease process for lease sale-specific NEPA reviews. If BOEM proceeds with a lease sale, BOEM 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. BOEM reviews a lessee’s plan(s) to conduct ancillary activities, and will allow them to go forward only if they meet regulatory requirements, including to not cause “undue or serious harm or damage to the human, marine, or coastal environment” (30 CFR 550.105, 550.202, and 550.209; see also, 43 USC 1340(c) (approval required prior to exploration); 43 USC 1351 (approval required prior to development and production)). The U.S. 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 blocks. Prior to any exploratory drilling, a lessee must submit an exploration plan (EP) to BOEM 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. BOEM must not approve an EP if the proposed activities, among other things, would cause "undue or serious harm or damage to the human, marine, or coastal environment" (30 CFR 550.202). 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 and production, 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 BOEM must review under NEPA. At least once in each OCS planning area, such as the Chukchi Sea Planning Area, a proposed DPP will be declared a major Federal action for which an EIS will be prepared (43 USC 1351(e)(1), 30 CFR 550.269(a)). If the DPP is approved, the lessee must also apply for specific pipeline, platform, and other permits for approval.

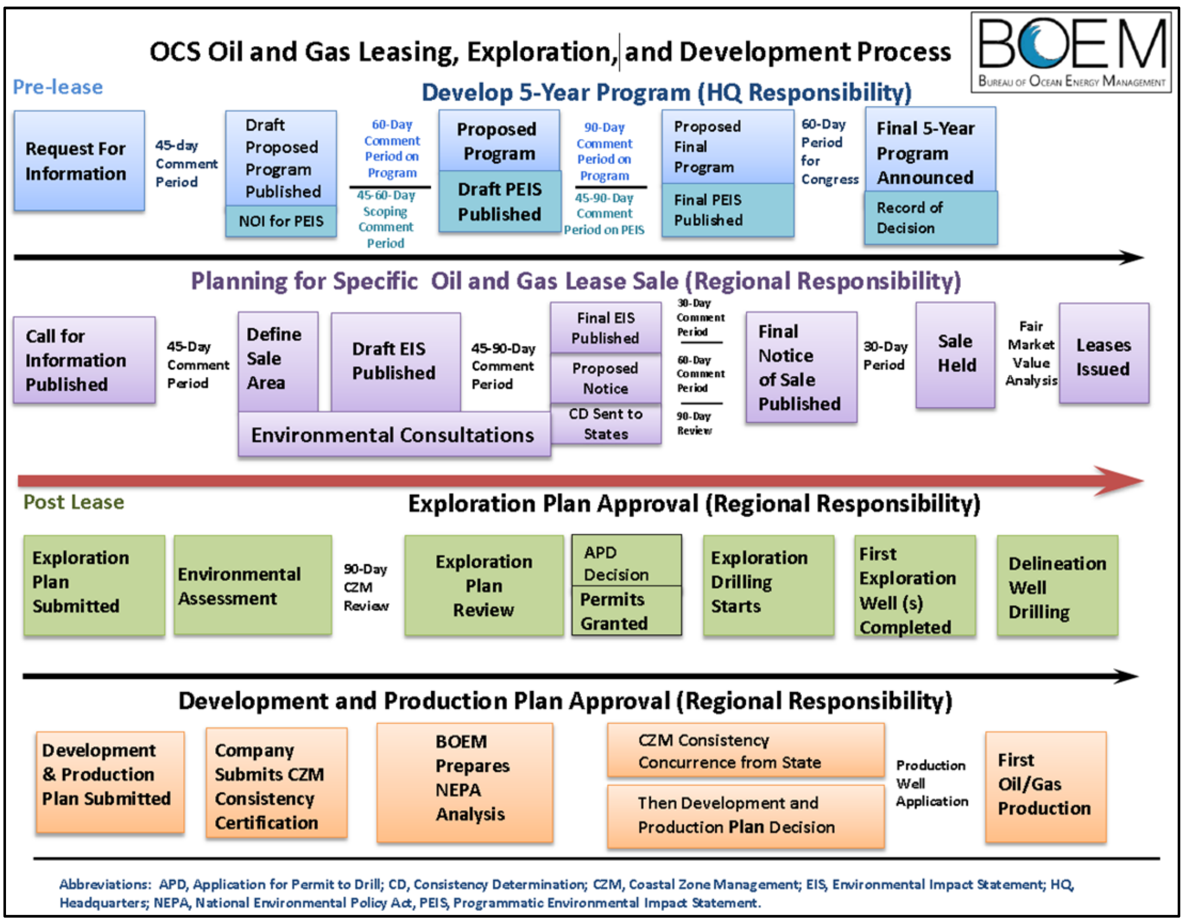

Figure 1-3. Four Stages of the OCSLA Oil and Gas Process.

The OCSLA four-stage oil and gas review process gives the Secretary a "continuing opportunity for making informed adjustments" in developing OCS 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)).

1.4.2. 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 analyzing the environmental impact of a major Federal Action. 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. An 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 USDOI regulations implementing NEPA are at 43 CFR Part 46.

1.4.3. 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 in 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 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. At present, the State of Alaska does not have a CZMA Program.

1.4.4. Notices and Information Provided to Lessees

To encourage lessees’ knowledge and appreciation of operational aspects and 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, BOEM develops and distributes the administrative documents described below. Additional information on these topics is available in the 2007 FEIS (Sections II.B.3.c(2) and II.B.3.c(3)).

Notice to Lessees

Notices to Lessees (NTL) are formal documents that provide clarification, description, or interpretation of a regulation or OCS standard; provide guidelines on the implementation of a special lease stipulation or regional requirement; provide a better understanding of the scope and meaning of a regulation by explaining BOEM interpretation of a requirement; or transmit administrative information. 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 BOEM’s website at http://www.boem.gov/notices-to-lessees-and-operators.

Information to Lessees

The Information to Lessee (ITLs) are statements for informational purposes. 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 BOEM requirements or reduce potential impacts. Still other ITLs provide information about the requirements or mitigation required by other Federal and State agencies. ITLs are effective in lowering potential impacts by alerting and informing lessees and their contractors about mitigation measures. The ITLs listed below apply to all OCS activities in the Chukchi Sea conducted pursuant to Lease Sale 193 leases and are considered part of the Proposed Action and each action alternative. The 2007 FEIS (Section II.B.3.c(3)) provides the full text and discussion of each ITL listed below. Applicable ITLs are also available at http://www.boem.gov/ak193/.

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

No. 25 – Review of Development and Production Plans

Since the publication of the 2007 FEIS, there have been changes to the ITLs for the lessees. Notably, the polar bear was listed as Threatened under the ESA in May 2008, as contemplated by ITL No. 15. Following the listing, BOEM and its predecessor agencies reinitiated consultation with U.S. Fish and Wildlife Service (USFWS). For more information see Section 6.4.2.

The Final Notice of Sale included ITL No. 25, Review of Development and Production Plans. This ITL was added to fully inform lessees that BOEM would be conducting additional NEPA 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. BOEM 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 DPPs. This may include biological surveys to identify environmentally sensitive areas such as:

- 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
- Pre-booming requirements for transfers of fuel, crude oil, persistent product, and oily ballast for all vessels operating in Alaska State waters

ITL 25 is provided to lessees for their planning purposes. The Final Notice of Sale provides the full text of this ITL at: http://www.boem.gov/ak193/.

1.5 Prelease Processes and Activities

A full history and description of the prelease process for Lease Sale 193 is provided in the 2007 FEIS (Section I.D). Regulatory provisions specific to leasing are in 30 CFR Part 556, 30 CFR Part 559, and 30 CFR Part 560.

1.6 Postlease Processes and Activities

BOEM’s duties include managing the orderly exploration, development, and production of energy and 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. Meanwhile, BSEE is responsible for regulating and monitoring oil and gas operations on the Federal OCS. Regulations applicable to oil, gas, and sulfur lease operations on the OCS are specified in 30 CFR Part 250. Oil-spill prevention and response rules are specified in 30 CFR Part 254. Note that additional regulations administered and enforced by agencies other than BOEM and BSEE also apply to OCS activities. A pertinent example includes U.S. Environmental Protection Agency (USEPA) regulations (40 CFR Part 125) concerning discharge of pollutants into water, as well as the myriad regulatory regimes identified in Section 1.4.

The following subsections briefly describe several means through which BOEM and BSEE regulate OCS postlease activities. For a full discussion of post-lease processes please refer to the 2007 FEIS (Section I.E).

1.6.1. Ancillary Activities

BOEM regulations at 30 CFR 550.207 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. Geohazard surveys are used to identify and characterize potentially hazardous conditions at or below the seafloor. They also identify potential benthic (occurring on or near the sea bottom) biological communities (or habitats) and archaeological resources. Geotechnical activities obtain physical and chemical data on surface and subsurface sediments.

Lessees or their Operators seeking to conduct ancillary activities must notify BOEM. Proposed ancillary activities are reviewed for compliance with the performance standards listed in 30 CFR 550.202(a), (b), (d), and (e).

1.6.2. Exploration Plans, and Development and Production Plans

BOEM approval is required prior to any exploration, development, production, or decommissioning activities within a lease block. Lessees seeking to engage in such actions must submit for BOEM review an Exploration Plan (EP) or a DPP, as appropriate. Proposed plans must include supporting information such as environmental information, an archaeological report, a biological report in accordance with 30 CFR Part 550 (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. BOEM 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 BOEM prepares an Environmental Assessment (EA) and/or an EIS based on available information, which may include the geophysical report, archaeological report, and air-emissions data. Proposed plans are evaluated for compliance with applicable regulations, lease stipulations, and other requirements.

Prior to conducting drilling operations, the operator is required to submit, and obtain approval for, an Application for Permit to Drill (APD) to BSEE. 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 BSEE'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.

1.6.3. Pipelines

Regulatory authority over pipelines on the OCS and in coastal areas is shared by several Federal agencies, including USDOI (which includes BOEM and BSEE), the U.S. Department of Transportation, the U.S. Army Corps of Engineers, the Federal Energy Regulatory Commission, the U.S. Coast Guard, and the State of Alaska for pipelines shoreward of three nautical miles (5.5 km). The USFWS reviews applications for pipelines that are near certain sensitive biological communities. State of Alaska standards and regulations would also be applicable when OCS pipelines tie into shore-based facilities, pump stations, or other pipelines when facilities, pump stations, or other pipelines are located in state-owned waters or tidelands within the 3 nm (5.6 km) state boundary.

BSEE regulations pertaining to pipelines are located at 30 CFR 250.1000–250.1019. Pipeline permit applications to BSEE contain several elements including pipeline location, safety plans, and archaeological reports. BSEE evaluates the design and fabrication of the pipeline and prepares an analysis of potential environmental impacts in accordance with applicable policies and guidelines. All pipeline rights-of-way on the OCS, including those that go ashore, will receive NEPA review. The operators are required to periodically inspect their routes by methods prescribed by the BSEE Regional Supervisor for any indication of pipeline leakage. Pipelines may be abandoned in place if they do not constitute a hazard to navigation and commercial fishing, or unduly interfere with other uses of the OCS. An abandoned pipeline would have to be flushed and cleaned to assure no residual hydrocarbon posed a risk to the environment.

1.6.4. Best Available and Safest Technology Requirements

To ensure all oil and gas exploration, development, production, and decommissioning activities on the OCS are conducted in a safe and pollution-free manner, the OCSLA 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
- Specifications for platform/structure designs

1.6.5. BSEE 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 BSEE 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 would 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.

1.6.6. Pollution Prevention and Oil-Spill Response

Safety and prevention of pollution, including accidental oil spills, are the primary focus of BSEE 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 Part 254, all owners and operators of oil-handling, oil-storage, or oil-transportation facilities located seaward of the coastline must submit an OSRP to BSEE 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 may 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 BSEE approval every two years. Revisions to a response plan must be submitted to BSEE within 15 days whenever any of the following occur:

- A change occurs that significantly reduces an owner/operator’s response capabilities.
- A significant change occurs in the worst-case-discharge scenario or in the type of oil being handled, stored, or transported at the facility.

- There is a change in the name or capabilities of the oil-spill-removal organizations cited in the plan.
- There is a significant change in the appropriate area contingency plans.

1.6.7. BSEE Inspection Program

Under the direction of the BSEE Alaska OCS Region, the BSEE inspection program provides review and inspection of oil and gas operations. BSEE conducts on-site inspections to ensure compliance with lease terms, Notices to Lessees, 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 is in the National Office Potential Incident of Noncompliance (INC) List (USDOI, BSEE, 2013a; http://www.bsee.gov/pinc/).

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 permits. BSEE expects to maintain a near continuous inspection presence during exploratory drilling activities on the OCS offshore Alaska. 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, BSEE will develop an inspection strategy commensurate with the scope and nature of such activities—the BSEE Alaska OCS Region conducts inspections of existing development and production facilities 3–4 times a year. Regardless whether the activity is exploration or development, BSEE will also conduct on-site inspections of all critical operations, including testing of blowout preventer (BOP) equipment, the running and cementing of casing, and well testing. The BSEE Alaska OCS Region has the authority and will issue an INC (a documented and recordable action) when a violation is found, and may 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 BSEE Alaska OCS Region has inspected and confirmed that the non-compliance or the shut-in has been properly corrected.

1.6.8. 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). BSEE 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.

1.6.9. 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, though training is job dependent and not everyone on the platform may have training in all aspects of the work conducted at the facility (30 CFR 250.1500-1510).

1.6.10. Safety and Environmental Management Systems (SEMS)

BSEE requires companies to develop, implement, and maintain a Safety and Environmental Management System (SEMS) program to promote safety and environmental protection. This program identifies, addresses, and manages safety, environmental hazards, and impacts during the design, construction, start up and operations to be conducted on the Outer Continental Shelf. The program also ensures that all personnel involved with the program receive appropriate training to perform their assigned duties.

1.7 New Information and Analysis Provided by this Second SEIS

This Second SEIS describes an updated oil and gas exploration, development, production, and decommissioning scenario for Lease Sale 193 (the Scenario), and then analyzes the potential direct, indirect, and cumulative environmental effects of the oil and gas activities described in that Scenario. This analysis includes relevant new information which has become available subsequent to the 2007 FEIS and the 2011 SEIS.

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Chapter 2

Alternatives and Exploration and Development Scenario

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CHAPTER 2. ALTERNATIVES AND EXPLORATION AND DEVELOPMENT SCENARIO

2.1. Lease Sale 193

The Secretary's Final Five-Year OCS Oil and Gas Leasing Program for 2007–2012 identified certain areas of the Chukchi Sea Planning Area suitable for leasing for the development of OCS oil and gas resources. In February 2008, MMS held Chukchi Sea OCS Oil and Gas Lease Sale 193 (Lease Sale 193) and offered for lease approximately 29.4 million acres in the Chukchi Sea Planning Area. As a result of Lease Sale 193, the Department issued 487 leases. Since that time, 27 leases have been relinquished; 460 leases remain. Additional information on the Five-Year Program and Lease Sale 193 is provided in Section 1.1.

The decision to offer this area for lease was supported by an EIS released by MMS in June 2007. (USDOI, MMS, 2007a). The decision was revisited in light of a July 21, 2010, remand order of the United States District Court for the District of Alaska. Based on a Final SEIS released by BOEMRE in August 2011, the Department reaffirmed Lease Sale 193 as held in 2008 ("Final Supplemental Environmental Impact Statement for Oil and Gas Lease Sale 193 in the Chukchi Sea, Alaska," August, 2011) (USDOI, BOEMRE, 2011a).

Both the 2007 FEIS and the 2011 Final SEIS considered four alternatives. These alternatives continue to represent a reasonable range of alternatives and are considered in the Second SEIS here.

No additional areas would be offered for lease as a result of the Second SEIS process, irrespective of which alternative is selected.

2.1.1. Alternatives

Alternative I (Proposed Action)

Alternative I entailed offering the entire Chukchi Sea Program Area for leasing. This area consisted of approximately 34 million acres within the Chukchi Sea. Specifically excluded from this alternative was the 25 Statute Mile (40 kilometer (km)) Buffer implemented by the Secretary in the Final OCS Leasing Program for 2007–2012.

Lease Sale 193 has already occurred. All of the leases originally issued are contained in the area covered by Alternative I. Accordingly, selecting Alternative I based on this Second SEIS process would result in affirming Lease Sale 193 and all of the leases.

Alternative II (No Lease Sale)

Alternative II, which is the "No Action" Alternative, entailed offering no areas in the Chukchi Sea for leasing.

Lease Sale 193 has already occurred. Selecting Alternative II based on this Second SEIS process would result in not affirming the lease sale and vacating the leases.

Alternative III (Corridor I Deferral)

Alternative III entailed offering the entire Chukchi Sea Program Area for leasing, minus a corridor (referred to as Corridor I) extending 60 miles (97 km) offshore along the coastward edge of the Program Area to protect important bowhead whale habitat. The area for leasing under this Alternative consisted of approximately 24 million acres in the Chukchi Sea.

Lease Sale 193 has already occurred. Five existing leases are contained within Corridor I. Accordingly, selecting Alternative III based on this Second SEIS process would result in affirming the lease sale, except the area in the Corridor I. As a result, all of the leases would be affirmed, except the five within Corridor I, which would be vacated.

Alternative IV (Corridor II Deferral)

Alternative IV entailed offering the entire Chukchi Sea Program Area for leasing, minus a corridor (referred to as Corridor II) along the coastward edge of the Program Area. The area covered by Corridor II was a subset of the area covered by Corridor I. The area for leasing under this Alternative consisted of 29.4 million acres. In February 2008, the Department offered for lease the area covered by Alternative IV in Lease Sale 193.

All leases are contained in the area covered by this alternative. Accordingly, selecting Alternative IV as a result of this Second SEIS process would result in affirming the lease sale and all of the leases.

The 2007 FEIS for the Outer Continental Shelf Oil and Gas Leasing Program 2007-2012 stated a preferred alternative that took into consideration the reasonable balance between the development of available hydrocarbon resources and the protection of the environment by excluding development in the most environmentally sensitive areas. The Final 2007-2012 OCS Oil and Gas Leasing Program acted on this preferred alternative by not offering for lease the OCS blocks within 25 miles (40 km) of the shore in the Chukchi Sea Planning Area in Lease Sale 193. Through further analysis of Lease Sale 193, Alternative IV was identified in the 2007 FEIS and the 2011 Final SEIS which included mitigating measures as the agency's preferred alternative. Alternative IV remains BOEM's preferred alternative in this Final Second SEIS because it continues to represent a reasonable balance between environmental, economic, and technical considerations mandated by the OCSLA. No new information or analysis tips the reasonable balance towards another alternative in this Final Second SEIS

Presentation of Alternatives in the Second SEIS Analysis

No additional areas would be offered for lease as a result of the Second SEIS process, irrespective of which alternative is selected. Accordingly, the maximum number of leases that could remain following the Second SEIS process is 460, which could result from the selection of either Alternative I or Alternative IV.

2.1.2. Alternatives Considered But Not Carried Forward for Further Analysis

A full discussion of alternatives considered within the EIS process but not carried forward for detailed analysis is available in the 2007 FEIS (Section II.B.2). BOEM did not identify any additional alternatives for this Second SEIS, beyond those already considered in the 2007 FEIS.

Among the new information considered by BOEM in assessing potential new alternatives were responses to the Call for Information and Nominations for Chukchi Sea OCS Oil and Gas Lease Sale 237, published in the Federal Register on September 27, 2013 (78 *FR* 59715). These responses included information from concerned stakeholders about portions of the Chukchi Sea Program Area that they believe should be excluded from leasing based on biological, socioeconomic, or other environmental information. Various stakeholders proposed fifteen exclusion areas for consideration in Lease Sale 237 based on such conditions. Many of these exclusion areas fall wholly outside of the Lease Sale 193 "Leased Area" considered in this Second SEIS and are therefore not considered further here. The proposed exclusion zones which do fall within portions of the Leased Area are:

- Hanna Shoal
- An expanded coastal buffer
- A northern portion of the Program Area

As the Sale 193 leased blocks contained within the latter two proposed exclusion zones are also fully encompassed within the largest proposed delineation of a proposed Hanna Shoal exclusion zone, and the justifications for each of the proposed exclusions pertain to the protection of marine mammals, the paragraphs below focus on the largest iteration of the proposed Hanna Shoal exclusion zone.

The importance of Hanna Shoal to a diversity of marine mammals has been elucidated by several recent and ongoing scientific studies funded by BOEM and other entities. Depending on seasonal timing and the nature of proposed operations, it is likely that proposed oil and gas activities conducted in this area could require consideration of mitigation measures to minimize adverse impacts to important biological resources such as walrus. There are several existing mechanisms through which appropriate mitigation measures would be implemented. The first is BOEM's plan-specific review process. BOEM conducts site- and time-specific environmental analysis of each proposed activity and will condition any approval upon whatever additional mitigations measures are necessary to comply with, at minimum, the substantive standards at 30 CFR §550.202. The second is through Stipulation No. 1, Protection of Biological Resources, which provides BOEM with the discretion to require lessees to conduct additional research and to implement additional operational restrictions in order to protect biological resources. Third, the MMPA contains a prohibition on "take" of marine mammals. To avoid potential liability under the MMPA, operators in the Arctic routinely apply for incidental take authorization under the MMPA. Prior to authorizing any incidental "take" of marine mammals, NMFS and/or USFWS must find that the taking would be of small numbers of marine mammals, have no more than a "negligible" impact on those marine mammals or stocks, and not have an unmitigable adverse impact on the availability of the species or stock for subsistence uses. With respect to walrus, the principal species of concern on Hanna Shoal, the USFWS has also incorporated into its Incidental Take Regulations special considerations for authorizing any incidental take associated with oil and gas exploration activities within the area it defined as the "Hanna Shoal Walrus Use Area" (HSWUA) during times of concentrated walrus use (50 CFR §18.118(a)(4)(v)). The USFWS has determined that additional mitigation measures may be required for activities within the HSWUA in order to minimize potential disturbance and ensure consistency with MMPA standards. These mitigation measures "include, but may not be limited to, seasonal restrictions, reduced vessel traffic, or rerouting of vessels." Minimum flight altitudes are also directed.

Because sufficient protections exist in Federal regulations and Lease Sale 193 lease stipulations to ensure that any routine activities conducted pursuant to Lease Sale 193 leases would be conducted in a manner that does not cause more than a "negligible" impact to marine mammals, consideration of a separate SEIS alternative designed to preclude such adverse effects to walrus and other marine mammals in the Hanna Shoal area is unnecessary.

It is also acknowledged that the likelihood of on-lease activities taking place within the suggested Hanna Shoal exclusion area is very low. Only 3-4% of the proposed exclusion area is covered by leases issued through Lease Sale 193, and those leases are on the periphery of the proposed exclusion area. Meanwhile, in almost six years since these leases were issued, no lessees have proposed exploring the areas at issue. Given the limited remaining duration of Lease Sale 193 lease terms and lessees' demonstrated focus on other portions of the Leased Area, it appears very unlikely that a plan-specific review of operations within the Hanna Shoal exclusion area would be required.

BOEM has also considered the public comments urging consideration of one or more alternatives designed to protect the resources in and around Hanna Shoal or other resource areas, and has determined that it remains unnecessary to analyze any of the suggested areas as stand-alone alternatives. In addition to the reasons noted above for not considering additional alternatives, BOEM notes that resource areas identified by commenters, including Hanna Shoal and Herald Shoal, are discussed in detail commensurate with the available scientific and traditional knowledge, as well as the area's relevance to this lease sale decision. For example, BOEM added additional detail in this Final Second SEIS pertaining to the significance of Hanna Shoal, including identifying potential impacts to the specific species for which Hanna Shoal is most important. Chapter 3 now includes a more detailed discussion of the various boundaries of Hanna Shoal, and what characteristics each delineation of the shoal seeks to include. Where relevant, the analysis in Chapter 4 explains how Scenario activities and oil spills in or around Hanna Shoal could affect resources using the shoal. Through taking this approach in its analysis, BOEM ensures that sufficient information is presented in the Second SEIS to inform a decision whether to require additional mitigation specific to any given area or to vacate certain leases to protect the area. Adding additional alternatives at the lease sale phase would only result in repetitive analysis.

2.2. Mitigation Measures and Issues Identified for Analysis

2.2.1. 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 the 2007 FEIS (Section II.B).

Discussion of potential mitigation measures, beyond those already required through lease stipulations or applicable law, is included throughout the Second SEIS, in the resource section for which the mitigation could reduce impacts. Most pertinent to the analysis of mitigation measures are the binding and enforceable measures known as lease stipulations, described below. There may be post-lease mitigation appropriate to consider at future phases when specific exploration and development plans are submitted.

Lease Stipulations

This Second SEIS analysis for each action alternative takes into account the implementation of seven lease stipulations listed below. The 2007 FEIS (Section II.B.3.c(1)) 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 are in Appendix D and were selected by the Secretary and incorporated into the leases resulting from Lease Sale 193 (February 2008). No additional lease stipulations have been proposed by BOEM to date, although additional stipulations could be implemented by the Secretary through the Record of Decision. The list of lease stipulations below remains comprehensive:

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

2.2.2. Issues

Issues related to OCS activities have been identified through many years of scoping for OCS lease sale evaluations, the 2007 FEIS process, and additional review conducted for the 2011 SEIS. A brief summary of identified issues related to the analysis of potential oil and gas activities in the Chukchi Sea is provided below. A comprehensive discussion of issues related to Lease Sale 193 is available in the 2007 FEIS (Section II.B.5).

Bowhead Whale

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

Marine Mammals

Concerns have been expressed regarding exploration and development activities and potential impacts to subsistence harvest of marine mammals.

Water Quality

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 air emissions.

Sociocultural and Socioeconomic

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

Western Arctic Herd

There is potential for onshore pipelines and other infrastructure associated with Chukchi Sea OCS development to impact the Western Arctic (caribou) Herd and subsistence use of the herd.

Environmental Resources

Resources analyzed in the 2007 FEIS were carried forward for analysis within the 2011 SEIS and this Second SEIS. These resources are listed below. No additional resources were identified for the analysis of oil and gas exploration, development, and production in this Second 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
- Sociocultural Systems
- Archaeological Resources

2.2.3. Issues Considered But Not Analyzed

The 2007 FEIS (Section II.B.5.b) provides a discussion of issues considered but not carried forward for further analysis. 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 2007 FEIS, and were summarized and made available to the decision-makers during the deliberation process. Several issues raised during scoping for the 2007 FEIS were not considered for detailed study in the EIS, because they were outside 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 during preparation of the 2011 SEIS or this Second SEIS process; however, BOEM did consider issues raised within responses to the Call for Information and Nominations for Lease Sale 237 and the public comment process of this Second SEIS process.

Gas Transportation Strategies

BOEM has considered and excluded the issues below from detailed analysis in this Second SEIS. The 2010 remand order by the U.S. District Court for the District of Alaska required BOEMRE to analyze the environmental impact of Chukchi Sea natural gas development. To determine an appropriate gas development and production scenario for the Lease Sale 193 Final Second SEIS, BOEM considered and rejected three possible gas export strategies for the Chukchi Sea OCS based on current understanding of the geologic, engineering, economic, and political issues.

At present, 35 Tcf of natural gas are stranded on the North Slope of Alaska because there is no transportation system to get the gas to market. Various projects have been put forth and studied since Trans-Alaska Pipeline (TAPS) was brought on line in 1977. However, low product prices, high capital costs, and legal and regulatory hurdles have prevented any project from being built. Gas production from the Chukchi Sea would be more economically favorable if there were an existing gas transportation system from the North Slope to market which could be utilized. Below are the three alternatives for gas transportation which were considered but not analyzed.

Onshore Natural Gas Pipelines.

Pipelines are the most cost-effective way to transport large volumes of oil or gas to market if overland routes are feasible. The natural gas transportation strategy in the 2011 SEIS utilized a series of pipelines to be built from the Chukchi Sea development to shore-based facilities, connecting to an onshore pipeline which would cross NPR-A to Prudhoe Bay.

The oil produced from offshore State of Alaska leases and Federal OCS leases in the Beaufort Sea are transported from wellhead to shore using subsea pipelines. More than 28 million barrels (MMbbl) of oil from Federal leases in the Northstar Unit have been transported this way since 2001. This oil is then fed into the TAPS and not into tankers. Tankers are not used until the oil is carried by TAPS to Valdez, where it is loaded onto tankers in Prince William Sound, an area which is not prone to the same ice and other harsh conditions as the Chukchi and Bering Seas.

Pipeline to Canada for further shipment to the Chicago, Illinois Hub.

The most promising proposed project in 2011 was an onshore gas pipeline from Prudhoe Bay through Alaska and into Canada, from where gas could be shipped to the Chicago, Illinois hub. Because of low natural gas prices and numerous regulatory hurdles this project faced, this idea is not considered to be a reasonable possibility.

Pipeline to south central Alaska for filtration and compression into LNG from Alaska

As of January 2015, the State of Alaska appears to be supporting an onshore gas pipeline from Prudhoe Bay to either the Cook Inlet area or the Valdez area. Gas would then be compressed into

LNG and shipped to market in LNG tankers. Over the last three decades, there have been numerous proposed projects, a substantial amount of money spent on studies, and some actual environmental work performed, but none have resulted in a viable, funded project. Sustained low long-term gas prices, along with very expensive infrastructure requirements (pipelines, gas conditioning facility, LNG facilities, LNG tankers) generally make Alaska North Slope gas development economically infeasible.

LNG Shipping Directly from the Chukchi Sea Onshore

In addition to pipelines, natural gas may be converted to Liquefied Natural Gas (LNG) and shipped to its destination in special tanker vessels. This is a second possible means to export gas from the Chukchi Sea OCS, using a pipeline to transport gas to a nearby onshore facility, where it would be converted to LNG and loaded on tankers for export. This scenario would require expensive infrastructure, including pipelines, a large processing facility, a marine loading terminal, and a fleet of LNG tankers capable of Arctic service, with the entire cost to be borne by this project. Numerous feasibility and environmental issues would 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 the severe ice conditions common in the Chukchi Sea. Nearshore areas are relatively shallow, and water depth could limit the size of LNG ships.

LNG Shipping directly from the Chukchi Sea OCS

A third strategy for gas development involves offshore processing, storage and loading to marine tankers for export. As with the onshore LNG processing scenario, an offshore-processing scenario would require expensive infrastructure, including pipelines, a large processing facility, a marine loading terminal, and a fleet of LNG tankers capable of Arctic service, with the entire cost to be borne by a single project. Other than issues with shallow water, the same feasibility, economic, and environmental issues would be present for this scenario as for the onshore processing plan.

Direct Tankering of LNG and Oil from the Chukchi Sea

Stipulation No. 3, Transportation of Hydrocarbons, in the lease instruments resulting from Lease Sale 193, specifies the conditions under which BOEM can require the transportation of hydrocarbons via pipelines. However, because Stipulation No. 3 does not expressly exclude other means of transportation, BOEM also revisited the question of how lessees would convey produced LNG or oil to market when it created a new Exploration and Development Scenario for this Second SEIS. Once again, BOEM concluded that direct tankering of LNG or oil from OCS Chukchi Sea development platforms is not a viable strategy; the only viable strategy is to convey produced gas or oil via pipeline.

There is no precedent for direct tankering of LNG or oil from locations featuring the ice conditions which characterize the leased area in the Chukchi Sea. While it is acknowledged that ice-hardened oil tankers are used or proposed to transport oil on a year-round basis in the Barents Sea and the Kara Sea, respectively, these areas are more protected from incursions of multi-year ice floes and/or have much less multi-year ice overall due to the warming effect of the Gulf Stream, and thus do not experience the same level of ice hazard as the Chukchi Sea. The Prirazlomnoye development, located in the eastern Barents Sea, uses small ice-class oil tankers, assisted by icebreakers, to shuttle oil to the Belokamenka floating platform located in ice-free waters in the western Barents Sea. The Prirazlomnoye development is located in just over 60 feet (18 m) of water and is located less than 40 miles (64 km) from the coast compared with Chukchi leases, which are in waters greater than 100 feet (30 m) in depth and more than 60 miles (97 km) offshore. The shuttle tankers used in the Prirazlomnoye development transport oil to the ice-free Belokamenka floating platform that is a little less than 700 miles (1,127 km) away. The closest ice-free area to the Chukchi Sea would be somewhere south of the Aleutians and would be nearly twice that distance. The location of the Prirazlomnoye development is much better shielded from multi-year ice than the Chukchi Sea and also has less severe ice conditions.

For tankering of LNG or oil to be attempted, ice-hardened tankers would be required in the Chukchi Sea. To be compliant with the Jones Act, the tankers would have to be constructed in the U.S. No ice-hardened tankers have ever been built in the U.S, and the U.S. shipbuilding industry has little experience with icebreakers in general. Even if an exception to the Jones Act were granted (or the substantial penalties for non-compliance were paid), the logistics of navigating the Bering and Chukchi Seas is formidable. Loading LNG or oil onto tankers at an OCS loading facility in the Chukchi Sea in winter ice conditions would likely require the continuous presence of very large, heavy-duty icebreakers. It is difficult to envision how this system would be viable given continual issues with weather, ice, and/or human error, any one of which could render conditions unsafe for LNG or oil loading. It is noted that, since acquiring their leases in 2008, industry has encountered challenges conducting seismic activities and exploration drilling activities, even in the summer seasons, due to lingering heavy multi-year ice over large portions of the leased area and surrounding areas. Year-round direct tankering would entail a host of new challenges. These past experiences would presumably discourage the use of vessels in such conditions where a proven alternative method – pipelines – is available.

While most scientists agree that the Arctic will have less multi-year ice in the future, the timeframe for these changes is not precisely defined, and it is usually discussed in terms of multiple decades or even over the next century. It is also unknown which specific areas of the Arctic will have less ice cover, especially given the variable impact of wind on the reduced ice environment. Based upon BOEM's understanding of the economics of oil development, there is insufficient certainty to support the assumptions about future ice conditions in the leased area that would be required to justify a multi-billion dollar business decision to pursue tankering.

It is assumed that, at minimum, 5 to 10 years of continuous, significantly reduced multi-year ice, in a particular area, would be required before companies would seriously consider tankering systems for transporting oil from the Chukchi Sea. Those conditions have not been in place for even one year since the lease sale. It therefore seems highly unlikely that a company would choose direct tankering over a pipeline for at least the next 20 years or so. Under the exploration and development scenario developed for Lease Sale 193, development of leases, including pipeline construction, would commence in Years 6-10. Considering this, and the fact that the leases in question are not issued for indefinite periods of time, it is not reasonable to believe that the Lease Sale 193 lessees would seek to transport oil or gas produced from these leases by tanker. The initial decision to use pipelines and the resulting infrastructure would then strongly influence the economics of production strategies for subsequent development assessed in this Second SEIS, including the cumulative case. Barring some unusual situation, industry is not likely to change transportation methods after constructing a pipeline infrastructure.

Additional Issues Associated with Tankering Oil Directly from the Chukchi Sea

The risks of inaccurately predicting when the ice will be at a reduced level for long-term purposes in a specific location are high. Having even one winter with a shutdown of a month in the life of an oil development and production project would likely result in catastrophic economic and technical consequences for the project. For example, shutting down production likely would cause serious damage to the reservoir, thus reducing ultimate oil recovery. The oil in gathering pipelines between platforms and subsea templates would solidify, rendering them useless. These pipelines are not designed to be shut down (except for short periods of time) because of this issue. Remediating or replacing these gathering pipelines would be very expensive and time-consuming. This would disrupt all oil delivery aspects of the Chukchi Sea developments, including the tankers and refineries that have long-term contracts to purchase the produced oil. Restarting all of these facilities would also be expensive and time-consuming. The company's revenue stream from this project would stop abruptly, calling into question the long-term viability of the project.

BOEM also has a regulatory responsibility to conserve resources. Since a shutdown of the facility for a month or longer would negatively impact the ultimate recovery of oil, direct tankering may not be approved as a means of transport due to the potential negative impact of a shutdown event on ultimate oil and gas recovery.

Overall, the risks associated with direct tankering LNG or oil from the leased area remain too high for direct tankering to be considered a viable strategy, especially when a more proven strategy (i.e., pipelines) exists.

Using ice hardened shuttle tankers in the Chukchi Sea for primary transportation of oil has all of the problems listed above with direct tankering. In addition, the cost to build and operate another massive facility to offload oil from the shuttle tankers, store the oil in tanks, and then reload the oil into normal tankers would greatly burden the economic viability of any development.

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 pursuant to OCSLA nor enforced by the Federal Government.

2.3. Exploration and Development Scenario

This section describes the Lease Sale 193 exploration, development, production, and decommissioning scenario (Scenario) that provides the foundation for the environmental effects analysis of this Second SEIS. The Scenario (Section 2.3.5) describes the types of oil and gas activities that could occur as a result of the Proposed Action, and provides an estimate of the timing, frequency, and duration of these activities. The Scenario establishes a basis for the analysis of potential direct, indirect, and cumulative environmental impacts.

The Scenario is described within a larger context of BOEM's resource assessment and scenario development processes, expected oil and gas development strategies, historical trends, and other pertinent topics. The discussion in this section illustrates a multi-step process whereby BOEM progresses from broad estimates of how much oil and gas resources may exist in a Planning Area to more specific estimates of how much of these resources could potentially be produced as a result of a given lease sale within that area. This discussion also highlights how the unique circumstances of the Lease Sale 193 Second SEIS – prepared after Lease Sale 193 has been held – enables BOEM to create a more focused exploration, development, production, and decommissioning scenario than is normally possible.

2.3.1. Resource Assessments

The Department of the Interior conducts resource assessments for all Planning Areas of the OCS. These assessments help the United States Department of the Interior (USDOI) to identify areas of the OCS that are most promising for oil and gas development, thus furthering its larger mandate under the OCSLA to make the oil and gas resources of the OCS available for expeditious and orderly development. The most recent assessment was completed in 2011 (see http://www.boem.gov/national-assessment-of-oil-and-gas-resources-2011/) (USDOI, BOEM, 2011a).

In these assessments, BOEM estimates two values:

- Undiscovered Technically Recoverable Resources (UTRR)

- Undiscovered Economically Recoverable Resources (UERR)

UTRR refers to quantities of hydrocarbon resources expected to be present in undiscovered oil and gas pools within a petroleum exploration play using conventional technology and exploration and development efficiency available or reasonably foreseeable at the time of the assessment (a pool is a discovered accumulation of hydrocarbons, generally within a single stratigraphic interval; a play is a group of pools that share a common history of hydrocarbon generation, migration, reservoir development, and entrapment). UTRR represents resources in undiscovered accumulations producible with conventional recovery techniques. The UTRR speaks more to the basic question, “How much oil and gas is in the ground?” (see http://www.boem.gov/national-assessment-history). UTRR is estimated without regard to constraints such as:

- Limitations on access to the entire Planning Area
- Difficulty/impossibility of drilling every prospect in the Planning Area
- Logistical constraints on drilling
- Economic constraints

No explicit consideration of economic constraints or viability is used in the estimation of UTRR resources. In the 2011 National Assessment, BOEM estimated a mean UTRR of 15.4 Bbbl for all 29 petroleum exploration plays in the Chukchi Sea Planning Area.

By contrast, UERR refers to that portion of the UTRR that could be explored, developed, and commercially produced at given cost and price considerations using present or reasonably foreseeable technology. In other words, UERR imposes certain economic constraints on the UTRR estimate and speaks to the question, “How much of this oil and gas could be worth producing?” The estimates of economically recoverable resources are presented as a range of resource values corresponding to different resource prices (see http://www.boem.gov/national-assessment-history). The UERR estimate accounts for certain basic factors affecting revenue (i.e. future price of oil, markets, tariffs, etc.) as well as projected costs of OCS exploration, development and production, and decommissioning.

In all other respects, UERR is estimated using the same very broad assumptions as UTRR:

- Unlimited access to all areas within the Planning Area
- Drilling of all prospects within the Planning Area
- No constraints on drilling

Like UTRR, the UERR estimate does not account for other important limiting factors such as regulatory restrictions and delays, litigation, logistical issues, infrastructure limitations, limited drilling seasons, and financial factors such as competing global opportunities for industry investment. For the 2011 National Assessment, BOEM estimated a mean UERR of 11.5 Bbbl for all 29 plays in the Chukchi Sea Planning Area (assuming a starting price of $110/bbl).

Overall, UTRR and UERR provide a broad overview of the potential resource endowments of Planning Areas to help inform certain programmatic decisions concerning whether to offer an area for lease. However, neither UTRR nor UERR provides an estimate of how much oil and gas would be developed and produced from an individual lease sale. Broad programmatic resource assessments serve a fundamentally different purpose than individual development scenarios described later in this section, and are predicated on fundamentally different assumptions and methodologies. Figure 2-1 illustrates how estimates become increasingly focused as the agency moves from Planning Area-wide resource assessments to sale-specific exploration and development scenarios.

Only a small portion of a Planning Area’s economically recoverable resources can realistically be developed and produced from a given lease sale. Limiting factors include:

- Not all portions of the Planning Area are necessarily offered for lease
- Not all tracts offered for lease receive bids
- Not all bids are accepted
- Not all tracts leased are likely to be explored
- Not all exploration is successful
- Not all discoveries are likely to be developed and produced
- Not all resources in developed pools are likely to be produced

As the following subsection describes, the level of oil and gas activities that may result from a lease sale is also influenced by the characteristics of the area offered for lease.

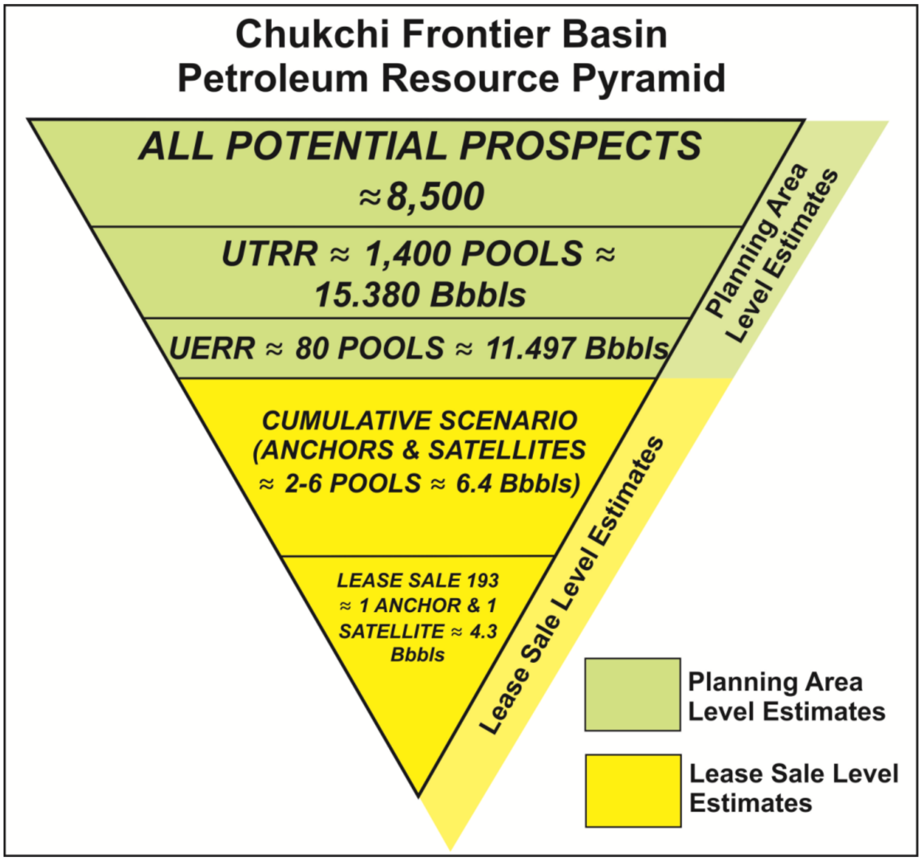

Figure 2-1. Refining Resource Assessment Estimates. *Based on a UERR of $110 per bbl, the inverted "pyramid" illustrates how BOEM refines broader regional resource assessment estimates (entire Planning Area) down to exploration-and-development scenario level estimates (individual lease sale). The cumulative scenario represents leases from Lease Sale 193 and reasonably foreseeable future lease sales in the area.*

2.3.2. Frontier Areas

Oil and gas exploration, development, and production activities proceed quite differently in mature areas versus frontier areas. Mature areas are characterized by a history of development and production, existing infrastructure, lower costs of doing business, and established access to market. In contrast, frontier areas are characterized by their remoteness, high costs of doing business, lack or scarcity of existing infrastructure, and lack of production data to inform forecasts of future activity. It is extremely costly to develop the infrastructure required to extract frontier area resources from the ground and transport them to market. Successful development and production of resources from frontier areas is therefore contingent upon successful exploration of an "anchor field" – a large discovery in the course of pioneering exploration that justifies the substantial capital investments required for an initial commercial petroleum development. Absent discovery of an anchor field, zero development and production would occur.

History on the Alaska OCS—a typical frontier area that is remote, costly, and relatively lacking in infrastructure for oil and gas development—illustrates the difficulties inherent in successfully developing and producing resources in such a region. Several once-promising OCS Planning Areas (Table 2-1) were eventually dismissed from future leasing plans after multiple unsuccessful attempts to discover an anchor field. Despite strong interest in leasing and considerable efforts to drill exploration wells, no oil was produced from these Planning Areas.

Table 2-1. History of Exploration Drilling on Once-Promising Alaska OCS Planning Areas.

OCS Planning Area offshore Alaska	Number of Exploration Wells	Quantity of Oil Discovered
Gulf of Alaska	12	0 Bbbl
Saint George Basin	10	0 Bbbl
Norton Basin	6	0 Bbbl
Navarin Basin	8	0 Bbbl

Lease Sale 193 offered blocks within the Chukchi Sea OCS Planning Area, an area in which, to date, oil and gas exploration has been similarly unsuccessful. In 1988 and 1991, MMS, (predecessor to BOEM) held Chukchi Sea OCS Oil and Gas Lease Sales 109 and 126, respectively. In these sales, industry spent $485 million acquiring 378 leases on the most promising prospects of the Chukchi Sea. Five exploration wells were drilled, testing the five largest prospects on the leased tracts. No significant accumulations of oil were found, and only one well indicated a significant (yet sub-economic) accumulation of natural gas. No commercial fields or reserves resulted from these leases, which were ultimately relinquished or expired.

Development Trends

In the event that an anchor field is discovered in a frontier area, any ensuing oil and gas development and production would be expected to proceed incrementally. Many lease sales and many years are generally required to produce a significant portion of an area’s oil and gas endowment. Take, for instance, the Gulf of Mexico OCS. The first field there was discovered in 1947. Since that time, approximately 87% of discovered oil and gas resources have been produced. Achieving this level of production has required an additional 67 years and 109 lease sales, despite the logistical advantages that were afforded by nearby infrastructure associated with development onshore and in state waters. Comparable infrastructure is lacking in and around the Chukchi Sea.

A closer analogue is provided by the Prudhoe Bay field along the eastern portion of the North Slope of Alaska. This extremely large discovery functioned as an anchor field, justifying the construction of the considerable infrastructure – most notably the 800 mi (1,287 km) TAPS – required to bring previously stranded oil to market. The Prudhoe Bay field was discovered in 1968 after 10 years of industry exploration of State of Alaska lands along the Arctic coast. Nine more years passed before the first oil was delivered through TAPS. As of today, approximately 17 Bbbl have been produced from the North Slope region. This level of production has resulted from 73 lease sales.

As a frontier area, the Chukchi Sea OCS would likely require similar timeframes and a multitude of lease sales to achieve a similar level of development and production. Section 2.3.5 describes activities that could occur as a result of Lease Sale 193 and other reasonably foreseeable lease sales in the Chukchi Sea.

2.3.3. Development Scenarios

Scenarios are conceptual views of the future and represent possible, though not necessarily probable, sets of activities. The timing of exploration and development activities, along with the volume of petroleum ultimately produced as a result of a Proposed Action, is impossible to predict with certainty. Within the Scenario, BOEM provides an estimate of what may occur by using best available methodologies based on the best available information as interpreted by the best professional judgment of its experts in the fields of geology, petroleum engineering, and economics.

This Scenario is necessarily predicated on many assumptions about what oil and gas activities may or may not occur over the course of the coming decades. Major assumptions are identified and explained in the subsections below. When confronted with a choice between competing reasonable assumptions, BOEM selected the assumption which contributed to the highest estimate of potential of oil and gas activities that could occur from the Proposed Action. In this manner, BOEM seeks to ensure that it considers the full range of likely production if oil production were to occur, that actual activities do not exceed the level described in the Scenario, and thus that all reasonably foreseeable environmental impacts are analyzed in this Second SEIS.

2.3.4. Lease Sale 193

Most of the Chukchi Sea Planning Area's 11,472 blocks were not leased as a result of Lease Sale 193. In the 2007-2012 Five-Year Program, the Secretary excluded a corridor from the Planning Area that stretched approximately 25 miles (40 km) from the northern shore of Alaska. This action removed more than 5,000 of the 11,472 blocks in the Planning Area from consideration for leasing. Then, in the Final Notice of Sale for Chukchi Sea OCS Oil and Gas Lease Sale 193, additional blocks along the coastward edge of the remaining lease sale area were removed from consideration. This additional deferral area was consistent with the deferral area proposed as "Corridor II" under Alternative IV in the 2007 FEIS. Thus, when Lease Sale 193 was held in February 2008, roughly 5,350 blocks were offered for leasing – less than half of the Planning Area.

The majority of blocks included within the lease sale area received no bids. BOEM accepted high bids on 487 blocks, which is fewer than 5% of the blocks in the Planning Area. Many of these blocks had been previously leased during the Lease Sale 109 process. In total, twenty-five of the twenty-nine exploration plays within the Chukchi Sea OCS Planning Area were either excluded from the lease sale area or did not attract bids during the lease sale. From the 2011 resource assessment and at a starting oil price of $110/bbl, these unleased plays contain 26% of the UTRR of the Chukchi Sea Planning Area and 34% of its UERR.

Because holding a valid lease is a prerequisite to drilling on a given block, Lease Sale 193 cannot lead to any oil and gas exploration, drilling, development, or production of resources underlying the nearly 11,000 unleased blocks in the Chukchi Sea.

In developing this Second SEIS, BOEM estimated the level of exploration, development, production, and decommissioning activities that reasonably could occur from the 487 leases issued during Lease Sale 193. BOEM developed the Scenario by using the best available methodology and applying best professional judgment to the best available information, which here includes knowledge of individual geologic prospects, data on prospect size and risk, the realities of infrastructure constraints, timing considerations such as finite primary lease terms and length of drilling seasons, and information on development costs. The unique circumstances surrounding this SEIS process also enabled BOEM to consider an additional type of valuable information – actual bidding data and results from Lease Sale 193 – not generally available in a lease sale EIS. The availability of this data provided better information on the actual prospects of interest and also enabled BOEM to use a more refined model to estimate different development outcomes and their likelihood.

Based on a calculated chance of drilling success of less than 20% and the history of drilling in the Chukchi Sea OCS, BOEM determined that zero production remains the most likely outcome from Lease Sale 193. However, assuming that development does occur, BOEM determined that one anchor field plus one satellite field could potentially be developed from Lease Sale 193 leases. A more detailed discussion of the methodology employed to reach these estimates is contained in Appendix B.

Using data from the existing leased prospects to more accurately develop the proxy fields analyzed here [1], BOEM estimated the anchor field could contain 2.9 Bbbl of recoverable oil, and the satellite field could contain 1.4 Bbbl of recoverable oil. Development of these fields would entail the drilling of 465 oil producing wells, 93 service wells, and installation of 8 platforms. The modeled anchor field and even the satellite field are larger than any field in the Gulf of Mexico OCS. The size of this Scenario represents an extreme "high case" of oil and gas activities from the Proposed Action. The discussion below explains how this Scenario would unfold over the course of several decades.

Additional development and production from Lease Sale 193 leases is not reasonably foreseeable given real world constraints such as:

- Finite lease terms (the analysis assumes the full 10 year primary term for the purpose of this analysis, despite the fact that roughly five of these years have passed). The leases have been under a suspension of operations twice that extended the lease term. OCSLA sets a primary lease term for five years; however, the Secretary can extend to up to ten years if the Secretary finds that such longer period is necessary to encourage exploration and development in areas because of unusually deep water or other unusually adverse conditions. Further, BSEE regulations at 30 CFR 250.180(a)2 specify that a lease may be extended beyond its primary term by drilling, well-reworking, or production in paying quantities.
- Short drilling seasons (lessees drill in open water, which exists for roughly four to six months per year in the Chukchi Sea).
- Limited availability of suitable drilling rigs (only a few rigs worldwide are suitable now for drilling in Chukchi Sea conditions).
- Other infrastructure requirements (i.e. the capital, materials, machinery, vessels, qualified personnel, etc. required to pursue development of this scale in a frontier area; available capacity of the Trans-Alaska Pipeline System).
- Engineering challenges and expense associated with producing hydrocarbons and transporting them to market from a frontier area.

2.3.5. Second SEIS Exploration and Development Scenario

This is the description of the scenario for oil and natural gas exploration and development activities on the blocks leased in Sale 193 (Scenario). Scenarios are conceptual views of the future and represent possible, though not necessarily probable, sets of activities. The analysis for this Scenario is unusual because Lease Sale 193 has already occurred. With this knowledge, BOEM has projected potential development based upon the post-sale analysis of tracts that received bids. Because the Chukchi Sea OCS is a frontier area with minimal exploration and no current development, the

[1] The development scenarios for Lease Sale 193 and beyond are not based upon abstract oil pools forecast from the statistics of the resource assessment method. Rather, the development scenarios presented here are grounded in the potential undiscovered resource volumes of real prospects that are well-imaged in seismic data, that received significant industry bids in Lease Sale 193, and that are judged by BOEM and industry geoscientists to represent outstanding candidates for future large discoveries. All of the four prospects in the development-scenario portfolio share these positive geological attributes and are sufficiently near to one another to benefit from satellite-to-anchor hub relationships.

Scenario is based on professional judgment and the characteristics of analogous onshore developments. This Scenario is one possible outcome of a discovery and subsequent development of two prospects (geologic features with the potential for trapping and accumulating hydrocarbons).

There are four phases in this Scenario:

- Exploration
- Development
- Production
- Decommissioning

Three lease sales offered Chukchi Sea leases prior to Lease Sale 193 (Chukchi Sea Lease Sales 109 (1988) and 126 (1991), and Beaufort Sea Lease Sale 97 (1988)), and five exploration wells were drilled between 1989 and 1991 (Table 2-2). The wells tested five large prospects, but did not find commercial volumes of oil. Operators either relinquished their leases or allowed them to expire. Using the past to predict future activity in the Chukchi Sea OCS, operators would likely purchase some leases, drill a few failed exploration wells, and relinquish the leases. Several other Alaska OCS Planning Areas have followed this pattern. However, for the purpose of this analysis, it is assumed that exploration would be successful and two prospects would be developed and produced.

Table 2-2. Historic Exploration and Development Wells in the Alaska OCS Planning Area.

Alaska OCS Planning Area	Exploration Wells	Development Wells
Chukchi Sea	5	0
Gulf of Alaska	12	0
Kodiak	0	0
Cook Inlet	13	0
Saint George Basin	10	0
North Aleutian Basin	0	0
Norton Basin	6	0
Navarin Basin	8	0
Beaufort Sea	30	7
Total	84	7

BOEM's 2011 Resource Assessment estimates that the Chukchi Sea OCS potentially contains significant concentrations of naturally-occurring hydrocarbons that can conceivably be discovered and recovered. The report estimates that the Chukchi Sea OCS contains a mean UTRR of 15.4 billion Bbbl and 76.8 Tcf of gas. These volumes could conceivably be discovered and produced with conventional industry technology. Resource estimates are based on seismic data, information obtained from the five exploration wells, and extrapolation of geologic trends from existing onshore fields hundreds of miles away. As previously noted, the UTRRs do not take into consideration any limiting economic or logistical factors. BOEM also estimates UERR at different price levels. In BOEM's latest Resource Assessment, at a $110 per barrel oil price, 11.5 Bbbl of oil (75% of the UTRR) in the Planning Area could be economic to develop, if discovered.

Even high quality seismic data can only indicate possible sites to explore. Seismic data must be interpreted by experienced geoscientists. As with all human interpretation, results are variable; even experienced interpreters may get different results from the same data set. The best seismic data and interpretation cannot indicate whether a reservoir contains hydrocarbons, much less whether it would be economic to produce. Seismic data does not indicate rock properties that determine how fluids will flow or properties of the fluids themselves. Only well drilling and testing can provide this information.

Prospects

As discussed in Section 2.3.2, development in a frontier area would likely start with a relatively large prospect to support the cost of initial infrastructure and to offer enough potential reward to make an operator decide to take the financial risk of development. Once this first anchor prospect is proven economic, a smaller nearby prospect could be added to capitalize on some of the existing infrastructure, such as pipelines, processing equipment, and shore-based plants.

In this Scenario, a large prospect, Anchor A, and a smaller satellite prospect, A-2, are discovered, developed, and produced from Sale 193 leases. Their combined potential oil and condensate are 4.3 Bbbl, which is 37% of the estimated UERR in the entire Chukchi Sea OCS at $110/bbl of oil (USDOI, BOEM, 2011a). Producing this volume of oil and its associated natural gas would require eight platforms of a new Arctic-class design and drilling 589 wells (exploration, delineation, production, and service.) The time from exploration to final production is 74 years. Table 2-3 shows the Scenario schedule. More detail regarding the Scenario development and methodology is provided in Appendix B.

The schedule is deliberately compressed to provide analysts with a maximum possible level of activity on which to base their impact analyses. It also assumes that there are no construction delays for platforms, regulatory delays of any kind, or delays for litigation. BOEM assumes immediate commitment from the operator(s) after a successful exploration program, with no funding delays, and that all operators coordinate and cooperate successfully.

Table 2-3. Exploration and Development Scenario Schedule for Anchor A and Satellite A-2.

Activity	Beginning Year	Ending Year	Total Years
Perform Marine Seismic Surveys	1	25	25
Perform Geohazard Surveys	1	28	28
Perform Geotechnical Surveys	1	28	28
Drill Exploration and Delineation Wells	3	22	20
Install Onshore Oil Pipeline	6	9	4
Install Offshore Oil Pipelines	6	30	25
Install Platforms	10	30	21
Drill Production and Service Wells	10	34	25
Oil Production	10	53	44
Install Onshore Gas Pipeline	27	31	4
Install Offshore Gas Pipelines	27	50	24
Gas Production	31	74	44

Scenario Schedule

Exploration Activities

Marine Seismic Surveys. Before exploration drilling occurs on leases, companies would conduct deep penetration seismic surveys to search for and define the prospective areas that could contain hydrocarbon deposits. Companies would generally conduct two-dimensional (2D) or three-dimensional (3D) geophysical seismic surveys to identify areas of interest. 2D deep penetration seismic surveying techniques are used to provide broad-scale information over a relatively large area and are mostly used for pre-lease exploration or to provide geologic information. 3D deep penetration seismic surveys are conducted on a closely spaced grid pattern that provides a more detailed image of the prospect which is used to select the proposed drilling locations.

BOEM's Scenario assumes that seven marine seismic surveys would be conducted as a direct result of Lease Sale 193 during the first 25 years of the Scenario. These seven marine surveys only occur because this lease sale was held. The typical marine seismic survey would be conducted during the open-water season from July 1st into November.

Airguns are generally the acoustic (sound) source for marine seismic surveys. An outgoing sound signal is created by releasing a high-pressure air pulse from the airguns into the water to produce an air-filled cavity (a bubble) that expands and contracts. The size of individual airguns could range from tens to several hundred cubic inches (in^3). A group of airguns is usually deployed in an array to produce a more downward-focused sound signal. Airgun array volumes for marine seismic surveys are expected to range from 1,800-4,500 in^3, (29.5 liters (L)) but may range up to 6,000 in^3 (98 L). The airguns are fired at short, regular intervals, so the arrays emit pulsed rather than continuous sound. While most of the energy is focused downward and the short duration of each pulse limits the total energy into the water column, the sound can propagate horizontally for several km (Greene and Richardson, 1988; Hall et al., 1994). Marine 3D seismic surveys vary from typical 2D seismic surveys, because the survey lines are more closely spaced and are more concentrated in a particular area. The specifications of a 3D seismic survey depend on client needs, the subsurface geology, water depth, and geological target. A 3D source array generally consists of two to three subarrays of six to nine airguns each. Source-array size can be varied during the seismic survey to optimize the resolution of the geophysical data collected at any particular site. The energy output of the array is determined more by the number of guns than by the total array volume (Fontana, 2003, pers. Communication, as cited in 2007 FEIS (page III-26.). Vessels usually tow up to three source arrays, depending on the survey-design specifications. Most operations use a single source vessel; however, in a few instances, more than one source vessel is used. The vessels conducting these seismic surveys generally are 70-90 m (230-295 ft) long.

The sound-source level (zero-to-peak) associated with typical 3D seismic surveys ranges between 233 and 240 decibels (dB) re 1 microPascal (µPa) at 1 m (dB re 1 µPa at 1 m) (root mean squared (rms). Marine 3D seismic surveys are generally acquired at vessel speeds of 4.5 knots (kn) (8.3 km/hour). A source array is activated approximately every 10-15 seconds, depending on vessel speed. The timing between outgoing sound signals may vary for different surveys to achieve the desired “shot point” spacing to meet the geological objectives of the survey; spacing is generally either 25 or 37.5 m (82 or 123 ft).

The sound receivers could include multiple (4-16) streamer-receiver cables towed behind the source array. Streamer cables contain numerous hydrophone elements at fixed distances within each cable. Each streamer could be 3-8 km (1.9-5 mi) long with an overall array width of up to 1,500 m (4,921 ft) between outermost streamer cables. Biodegradable liquid paraffin is used to fill the streamer and provide buoyancy. Solid/gel streamer cables are also used.

The wide extent of this towed equipment limits both the turning speed and the area a vessel covers with a single pass over a geologic target. It is, therefore, common practice to acquire data using an offset racetrack pattern, whereby each acquisition line is several km away from and traversed in the opposite direction of the track line just completed. Acquiring a single track line may take several hours, depending on the size of the survey area. The vessel then takes 2-3 hours to turn around at the end of the track line and starts acquiring data along the next track line. Adjacent transit lines for a modern 3D seismic survey generally are spaced several hundred meters apart and are parallel to each other across the survey area. Seismic surveys are conducted day and night when ocean conditions are favorable, and one survey effort may continue for weeks or months, depending on the size of the survey. Data-acquisition is affected by number of streamer cables towed by the survey vessel and by weather/ice conditions. Generally, data are only collected between 25% and 30% of the time (or 6-8 hours a day) because of equipment or weather problems. In addition to downtime due to weather, sea conditions, turning between lines, and equipment maintenance, seismic surveys could be suspended for biological reasons (proximity to protected species). Individual seismic surveys could require 60-90 days to cover a 200 square mile (mi^2) (518 km^2) area.

Marine 2D seismic surveys use similar geophysical-survey techniques as 3D seismic surveys, but both the mode of operation and general vessel type used are different. The 2D seismic surveys provide a less-detailed subsurface image because the survey lines are spaced farther apart, for coverage of wider areas to image geologic structure on more of a regional basis. Large prospects are easily identified on 2D seismic data, but detailed images of the prospective areas within a prospect can only be seen using 3D data. The 2D seismic-survey vessels generally are smaller than modern 3D-seismic survey vessels, although larger 3D survey vessels are able to conduct 2D surveys. The 2D seismic-sound source array generally consists of three or more arrays of six to eight airguns each, equivalent to the arrays used for 3D surveys. The sound-source level (zero-to-peak) associated with 2D marine seismic surveys are the same as 3D marine seismic surveys (233-240 dB re 1 μPa at 1 m). Generally, a single hydrophone streamer cable approximately 8-12 km (5-7.5 mi) long is towed behind the survey vessel. The 2D seismic surveys acquire data along single track lines that are spread more widely apart (usually several miles) than are track lines for 3D seismic surveys (usually several hundred meters).

Marine seismic vessels are designed to operate for weeks without refueling or resupply. A support vessel is generally used for safety considerations, general support, maintenance, and resupply of the main vessel, but it would not be directly involved with the collection of seismic data.

Marine seismic surveys require a largely ice-free environment to allow effective operation and maneuvering of the airgun arrays and long streamers. One exception to the need for a largely ice-free environment is the in-ice seismic survey. These seismic surveys use a specialized survey vessel with a special fitting that allows the streamer to be towed below the ice. These surveys require an icebreaker to clear a path through the ice for the survey vessel to follow. In-ice surveys could occur as late as late December, when the thickness of the ice becomes an issue. In the Arctic, the timing and areas of seismic surveys are often dictated by ice conditions.

The data-acquisition season in the Chukchi Sea OCS could start sometime in July (migration restriction) and end sometime in early November (for standard open-water seismic surveys) or in late December (for in-ice seismic surveys). Even during the short open-water season, there are periodic incursions of sea ice, so there is no guarantee that any given location would be ice free throughout the survey. Marine seismic exploration work began before the lease sale to identify prospective tracts for bidding. This work included 3D seismic surveys, but did not include exploration drilling. Approximately 100,000 line-mi (160,900 km) of 2D seismic surveys have been collected in the Chukchi Sea OCS program area. BOEM assumes that most of the additional geophysical seismic surveys would be 3D surveys focusing on specific leasing targets. The 3D surveys are likely to continue during the early phase of exploration when wells are drilled; however, the number of seismic surveys should decrease over time as data is collected over the prime prospects and these prospects are tested by drilling.

Ancillary Geohazard Surveys. An ancillary geohazard survey usually is conducted by the oil and gas industry to provide required information to Federal agencies about the site of proposed exploration and development activities. Ancillary geohazard surveys:

- Locate shallow hazards
- Obtain engineering data for placement of structures (e.g., proposed platform locations and pipeline routes)
- Detect geohazards, archaeological resources, and certain types of benthic communities

A typical operation may include a vessel towing an acoustic source (airgun) about 25 m (82 ft) behind the ship and a 600 m (1,969 ft) streamer cable with a tail buoy. The source array usually is a single array composed of one or more airguns. A 2D ancillary geohazard survey usually has a single airgun, while a 3D ancillary geohazard survey usually tows an array of airguns that are generally smaller in volume than the arrays used in marine seismic exploration activities. The ships travel at 3-3.5 kn (5.6-6.5 km/hour), and the source is activated every 7-8 seconds (or about every 12.5 m (41 ft)). All vessel operations are designed to be ultra-quiet, as the higher frequencies used in ancillary geohazard work are easily masked by the vessel noise.

Generally, seismic surveys cover one proposed drilling location at a time. Federal regulations require information be gathered on a 300 by 900 m (984 x 2,953 ft) grid, which amounts to about 129 line km (80 mi) of data per lease block (Notice to Lessees No. 05-A01). If there is a high probability of archeological resources, the north-south lines are 50 m (164 ft) apart and the 900 m (2,953 ft) remains the same. Including line turns, the time to survey a lease block is approximately 36 hours. Airgun volumes for ancillary geohazard surveys generally are 90-150 in^3 (1.5-2.5 L), and the output of a 90-in^3 (1.5 L) airgun ranges from 229-233 dB high-resolution re 1μPa at 1 m. Airgun pressures generally are 2,000 pounds per square inch (psi), although they can be used at 3,000 psi for higher signal strength to collect data from deep in the subsurface.

Exploration and Delineation Drilling. Operators would drill exploration wells based on mapping of subsurface structures using marine seismic data. Prior to drilling exploration wells, operators would perform ancillary geohazard surveys and geotechnical studies to examine the proposed exploration drilling locations for geologic hazards, archeological features, and biological populations. Site clearance and other studies required for exploration would be conducted during the open-water season before the drill rig is mobilized to the site.

Exploration drilling operations are likely to employ Mobile Offshore Drilling Units (MODUs) with ice management vessels. Examples of MODUs include drillships, semisubmersibles, and jackup rigs. Drilling operations are expected to range between 30 and 90 days at different well sites, depending on the depth of the well, delays during drilling, and time needed for well logging and testing operations. Considering the relatively short open-water season in the Chukchi Sea OCS, BOEM estimates that two wells per drilling rig could be drilled, tested, and decommissioned during a single open-water season. Drilling operations would be supported by resupply vessels and, most likely, ice management vessels.

Exploration drilling programs would also entail oil-spill response and cleanup vessels and equipment, which may be staged near the drilling area or in more protected nearshore areas, such as Goodhope Bay in Kotzebue Sound.

If a discovery is made during exploration well drilling, MODUs would drill delineation wells to determine the areal extent of economic production. Operators need to verify that sufficient volumes are present to justify the expense of installing a platform and pipelines.

As many as 40 wells could be associated with exploring and delineating these prospects, including unsuccessful exploration wells on other prospects in the Chukchi Sea OCS, the drilling of which could be prompted by news of the first commercial discovery. Even successful exploration and delineation wells would likely be plugged and decommissioned rather than converted to production wells because it would require several years before platforms and pipelines could be installed and oil produced. Leaving a well shut in for this length of time would be unlikely to be permitted by regulatory agencies.

Development and Production Activities

Development and production activities include drilling production wells and installing platforms and subsea templates, pipelines, and shorebases. After an operator committed to develop a prospect, project designs would be evaluated, and the operator would make development decisions based on, among other things, experience, expectations, and availability of equipment, personnel, and materiel. Different operators, with different sets of experiences and expectations, would make different decisions about how best to develop a prospect. The development plan is likely to undergo revision during the development phase as the operator incorporates lessons learned. Figure 2-2 below shows the schedule of platform installation and well drilling from the Scenario.

Platforms and Subsea Templates. Water depth, sea conditions, and ice conditions are important factors in selecting a platform type. Large, bottom-founded platforms are likely to be used in the Chukchi Sea OCS, where water depths are mostly more than 100 ft (30 m). Conceptual designs have been proposed that are circular in cross-section, with wide bases constructed out of concrete. The platform could be constructed in several component sections, which would be transported to the site and then mated together. The seafloor is expected to be relatively firm in the assumed development area, so a prepared berm may not be required. The platform base is pinned to the seafloor and stabilized by its wide base, anchoring system, and ballast in cavities in the concrete structure to resist ice forces. Each platform would have two drilling rigs capable of year-round drilling; BOEM estimates a maximum of eight wells per rig, or sixteen wells per platform per year. Each of the eight platforms in our scenario would house production and service (injection) wells, processing equipment, fuel and production storage capacity, and quarters for personnel. The first platform would be the hub, connecting pipelines from other platforms to the main pipelines to shore. It is assumed that oil would be piped to the shore as soon as it is processed. There would be some storage capacity on the platforms to accommodate periods of processing equipment downtimes.

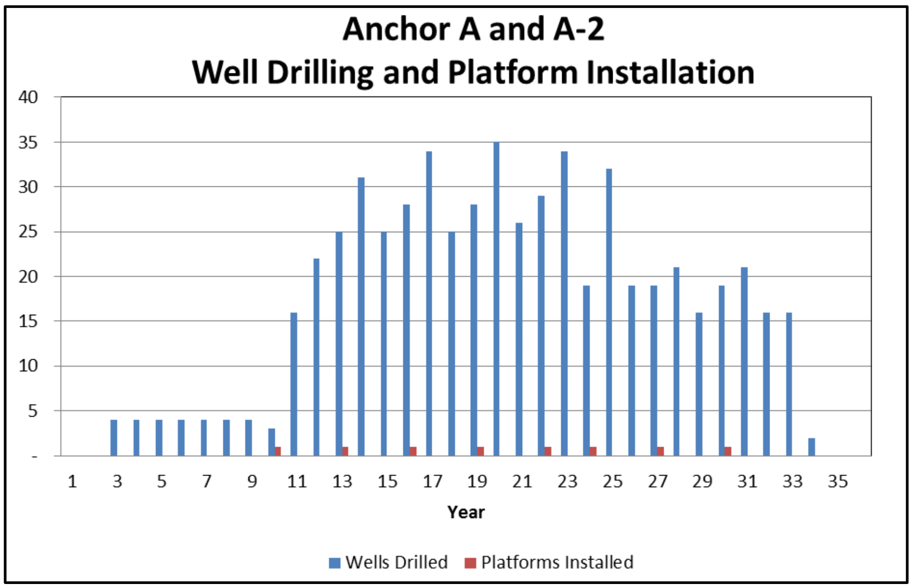

Figure 2-2. Development Scenario Schedule of Well Drilling and Platform Installation.

Ninety subsea production wells on fifteen subsea templates are anticipated under the development scenario. These subsea production wells would be drilled by MODUs during the summer drilling season. With efficiencies gained by repeated operations, BOEM assumes that a single MODU could drill up to three subsea wells in a single season. There would be six subsea production wells on each template, which would be tied back to a platform by a subsea flowline. Subsea well templates would be located within about 2 miles (3.2 km) of the host platforms, for a total of 30 miles (48 km) of subsea flowlines to host platforms. Subsea equipment and pipelines could be installed below the seafloor surface for protection against possible deep-keeled ice masses.

The production fluids (oil, gas, and water) would be gathered on the platforms where gas and produced water would be separated and gas and water reinjected into the reservoir using service wells. During the later gas sales phase, water would continue to be reinjected. Disposal wells would handle waste water from the crew quarters on the platforms. Treated well cuttings and mud wastes for platform and subsea wells could be reinjected in disposal wells or barged to an onshore treatment and disposal facility located at the shorebase.

Pipelines. Pipelines are the expected method of transporting both oil and gas to market. (see Section 2.2.3). Subsea pipelines would connect the platforms in our scenario to the hub platform, and trunk pipelines would carry oil and gas from the hub platform to the shorebase. The shorebase would provide additional processing and connect to onshore oil and gas pipelines which would be laid 300 miles (483 km) across the NPR-A to Prudhoe Bay. At Prudhoe Bay, the oil pipeline would connect with the TAPS and the gas pipeline would connect with the large-volume gas pipeline that has been proposed to carry gas from Prudhoe Bay to a port in south central Alaska.

In 1977, the 800 mi (1,287 km) TAPS commenced transporting oil from Prudhoe Bay to the ice-free port of Valdez, in south central Alaska. According to Alyeska Pipeline Service Company, TAPS's operator, the pipeline capacity is currently 1.1 MMbbl of oil per day; North Slope production is around 550 Mbbl per day in 2014. The Scenario uses the current available capacity of 550 Mbbl per day as the maximum rate of oil production that could be accepted into TAPS from the Chukchi Sea OCS. Because the production rates of the initial wells decline by the time later wells are brought onto production, TAPS capacity did not limit Scenario production at any point.

The gas produced from oil fields, such as Prudhoe Bay, is called associated gas because gas and produced water are byproducts of oil production, rather than being the primary product as from a gas field. There is currently no pipeline to get North Slope gas to market, so other than the gas consumed for North Slope operations, all of the associated gas is reinjected into the reservoirs to enhance oil recovery. Approximately 35 Tcf of proven natural gas reserves could be produced from North Slope reservoirs at Prudhoe Bay and Point Thomson if there were a way to transport it to market. To help encourage development of a North Slope natural gas line project, the state in 2013 entered into negotiations to take an equity stake in the project. The Legislature in April 2014 passed a bill (Senate Bill 138), which the governor signed into law in May 2014, which sets up a process for the state to become a 25% shareholder in the project, known as Alaska LNG. The proposed project includes a gas treatment plant on the North Slope to remove carbon dioxide and other impurities from the gas stream; an 800 mi (1,287 km) pipeline generally due south and eight compressor stations along the pipeline route; and a liquefaction plant, storage tanks and marine terminal in Nikiski, Alaska, to load and ship the LNG to world markets. The estimated cost of the project is $45 billion to $65 billion (2012 dollars), which includes all of the above plus substantial field development work at Point Thomson to produce gas for the project. The state's schedule says the first LNG shipments could start 2023-2024. The project developers are North Slope oil producers ExxonMobil, BP, and ConocoPhillips, and pipeline company TransCanada.

Many gas pipeline projects have been proposed since Prudhoe Bay commenced commercial oil production in 1977, but no project has been developed due to poor economics.

While pursuing the producer-led, large-volume gas pipeline project, the state is also working on a concurrent, state-funded proposal for a much smaller-capacity gas line from Prudhoe Bay to southcentral Alaska to provide natural gas for use in communities along the Railbelt from Fairbanks to the Kenai Peninsula. Even the smaller state-supported pipeline from Prudhoe Bay (estimated cost $5 billion to $10 billion) would require years to design, engineer, permit, and build. The state agency in charge of the project — which is described as a back-up plan if the larger, producer-led pipeline fails to proceed — says gas would not move down the line before 2020. If either pipeline were built, the 35 Tcf from the North Slope fields would probably be transported first; gas from the Chukchi Sea OCS would have to wait for pipeline capacity to become available. If the Chukchi Sea OCS is developed for oil production, immediate gas sales without a reinjection (gas-cycling) phase would also result in faster decline of reservoir pressures, reducing the total volume of oil ultimately produced. Our Scenario calls for gas production from the Chukchi Sea OCS to be delayed until Year 31, regardless of whether the larger producer-led gas pipeline project or smaller state-supported project proceeds.

Installation of subsea flowlines from subsea templates to the hub platform and from the hub platforms to shore would occur during summer open-water seasons. Pipeline installation operations would occur during the same timeframe as platform construction and installation. The offshore trunk pipelines (estimated total 160 miles (257 km) cumulative length under the Scenario) would run between the central OCS hub platform and the shore. They would be trenched in the seafloor as a protective measure against damage by floating ice masses. At the coast, a new facility would be constructed to support the OCS operations and would serve as the first pump station. A likely location for the shorebase would be between Icy Cape and Barrow.

The overland pipeline to TAPS through NPR-A would require coordination of different land managers and oil field owners along the route. In contrast to offshore pipelines, the new onshore pipeline would be installed during winter months. Various pipeline and communication lines would be installed on vertical supports above the tundra in a corridor stretching eastward 300 miles (483 km) to connect to the North Slope TAPS gathering system. Pump stations may be required along the onshore corridor and are likely to be collocated with oil fields along the corridor. When the time comes for the gas to be sold, the entire offshore and onshore pipeline installation process must be repeated with gas pipelines running parallel to oil pipelines.

Delineation drilling would take three to four years after a discovery. It would be followed by permitting activities for the OCS project, submission of an approvable Development and Production Plan by the operator, and an agency Development EIS. When the project is approved, the design, fabrication, and installation of each platform could take another four years. Offshore and onshore pipeline permitting and construction would occur simultaneously with the OCS work. The Scenario schedule requires the operator to commission subsequent platforms without an extended period of evaluation of the initial wells. Drilling the platform and subsea production wells would occur over a period of 24 years. A new shorebase would be constructed to support OCS work and then serve as the connection point for the trunk pipelines from the hub platform and the pipeline across the NPR-A.

After the offshore infrastructure was constructed, operations would largely involve resupply of materials and personnel, inspection of various systems, and maintenance and repair. Maintenance and repair work would be required on the platforms, and processing equipment would be upgraded to remove bottlenecks in production systems. Well repair work would be required to keep both production and service wells operational. Pipelines would be inspected and cleaned regularly by internal devices (“pigs”). Crews would be rotated at regular intervals.

Transportation. Operations at remote locations in the Chukchi Sea OCS Lease Sale 193 area would require transportation of supplies and personnel by different means, depending on seasonal constraints and phase of the operations. The general assumptions discussed in this section can be integrated with the Scenario schedule shown in Table 2-3 to determine the full extent of transportation activities associated with a large OCS development project.

During exploration seismic surveys, the vessels are largely self-contained. Therefore, helicopters would not be used for routine support of operations. With the exception of one in-ice survey, which would occur in November to early January, seismic operations would be in the summer/fall open-water season. BOEM assumes that the smaller support vessel would make occasional trips (one to three times, depending upon the duration of the activity), probably operating out of Barrow and/or Wainwright.

During exploration drilling, operations would be supported by both helicopters and supply vessels. Helicopters would fly from Barrow and/or Wainwright at a frequency of one to six flights per day. Support-vessel traffic would be one to three trips per week, also out of Barrow and/or Wainwright. For exploration-drilling operations that occur after a new shorebase is established, both helicopter and vessel traffic would be out of Barrow, Wainwright or the new shorebase.

Construction of a new shorebase would begin after a commercial discovery is made and after all necessary permits are acquired by the operator. Heavy equipment and materials would be moved to the coastal site using barges, aircraft, and perhaps winter ice roads. Transportation activities would be more frequent during the construction phase. During this construction phase, there could be one to two barge trips (possibly from either West Dock or Nome) in the summer open-water season. There could be as many as five transport aircraft (C-130 Hercules or larger) trips per day during peak periods. The overall level of transportation in and out of the shorebase would drop substantially after construction is completed for both the shorebase and offshore field area. During production operations, aircraft generally would be smaller, with less-frequent flights (2 per day). Ice-road traffic would be intermittent during the winter months.

OCS/offshore construction (platform and pipeline installation) and development drilling operations would be supported by both helicopters and supply vessels from the new shorebase. Helicopters would fly from Barrow, Wainwright, or the new shorebase at a frequency of one to three flights per platform per day during development operations. Support-vessel traffic would be one to three trips per platform per week from Barrow, Wainwright, or the new shorebase. During normal production operations, the frequency of helicopter flights offshore would remain the same (1-3 platforms per day), but marine traffic would drop to about one trip every 1-2 weeks to each platform. Marine traffic would occur during the open-water season and possibly during periods of broken ice with ice-reinforced vessels. Assuming that barges would be used to transport drill cuttings and spent mud from subsea wells to an onshore disposal facility, BOEM estimates one barge trip per subsea template (15 templates). This means that there could be two barge trips (during summer) to the new onshore facility each year for a period of twelve years.

Production Activities

Oil production would commence once sufficient production capability to maintain a minimum level of throughput on the line is achieved; the Scenario assumes this would occur with the drilling of the first platform production well, and would ramp up as more wells are drilled. When the oil resources are depleted, oil production and gas injection (service) wells would be converted to gas production. Service wells would continue to reinject produced water throughout oil and gas sales operations. Figure 2-3 shows the forecasted yearly oil and gas sales.

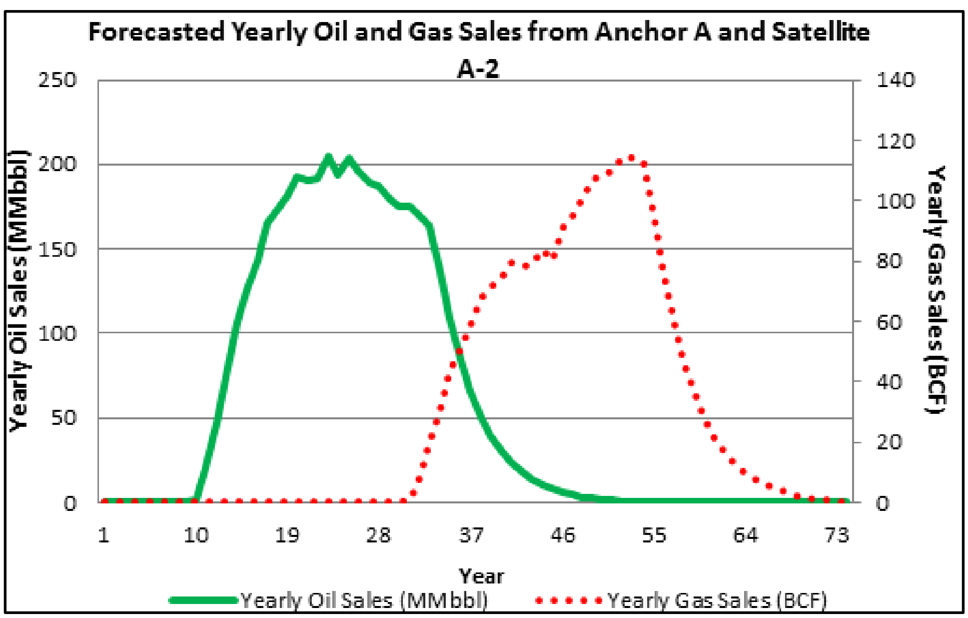

Figure 2-3. Forecast of Annual Oil and Gas Lease Sales from Anchor A and Satellite A-2.
Notes: MMbbl- Million barrels, BCF – Billion Cubic Feet

Timing. Three factors were evaluated for possible influence on the length of time needed to complete the development and production phases of this Scenario.

- Gas sales would be delayed until oil production was nearly complete
- Available TAPS capacity is limited
- It would take twenty years to install all the platforms. This controls how quickly wells could be drilled

The delay of gas sales strongly influences the length of time for the production phase, but the current lack of a pipeline from the North Slope to south central Alaska and the need to maximize oil production make this the most likely production strategy.

The issue of available TAPS capacity has also been evaluated. This limit was used as a check to ascertain that adding production from the Satellite A-2 would not exceed available capacity. Pipeline capacity limits created no delay in bringing the satellite field into production. The real driver of the timeline is the time needed to install platforms and drill their associated wells. The platform design used in this Scenario has never been built. Each platform would be designed specifically for its proposed location, built in a shipyard (often in Asia), and towed into place. Construction time is estimated to be four years. The design of each new platform would likely be modified based on the operation of previous platforms. There is no allowance in the schedule for redesign, construction delays, or installation issues. Platform installation occurs every third year in the scenario. Each platform is installed, commissioned, and producing in its first year. There are no regulatory or legal delays factored into the schedule. Table 2-4 below summarizes Scenario results.

Table 2-4. Scenario Results for Development of Anchor A and Satellite A-2 Oil Prospects.

Element	Range	Comment
Marine Seismic Surveys	4-12	Would vary based on number of operators
Geohazard Surveys	10-16	Would vary based on number of operators
Geotechnical Surveys	10-16	Would vary based on number of operators
Platforms	8	
Exploration and Delineation Wells	30-40	Includes dry holes and unsuccessful wells on other Chukchi Sea OCS prospects drilled after a success
Production Wells	400-457	457 required to produce all the recoverable oil
Service Wells	80-92	20% of production wells
Onshore Oil Pipeline (miles)	300-320 (483-514 km)	Longer distance may be required for rerouting
Onshore Gas Pipeline (miles)	300-320 (483-514 km)	Longer distance may be required for rerouting
Offshore Oil Pipeline (miles)	190-210 (306-338 km)	Miles would vary based on location of actual prospects
Offshore Gas Pipeline (miles)	190-210 (306-338 km)	Miles would vary based on location of actual prospects
Total Oil Production (Bbbl)	4.0-4.3	
Total Gas Production (Tcf)	2.0-2.2	
Peak Oil Rate (barrels/day) (bbl/d)	558,702	
Peak Gas Rate thousand cubic ft (MCF/day)	314,618	
New Pipelines to Shore	2	1 oil trunkline, followed by 1 gas trunkline in same corridor near Wainwright
New Shorebase	1	Near Wainwright
New processing facility	1	At new shorebase
New waste facility	1	At new shorebase
Drilling fluids from exploration and delineation wells (tons)	2850-3800	475 tons/well, with 80% recycled drilling fluid from intermediate and production strings
Rock cuttings discharge for exploration and delineation wells (tons)	18,000 – 24,000	600 tons/well
Discharges for Service into the water and Production Wells (tons)	0	Drilling fluid and rock cuttings would be disposed of in service wells or barged to shore for disposal.
Flights per week during production phase	56-168	1 to 3 flights per platform per day
Boat Trips per week during production phase	8-16	1 to 2 trips per platform per week
Years of Activity	70-74	Final gas production may be truncated for economic reasons

Abandonment/Decommissioning Activities

After both oil and gas resources are depleted and income from production no longer pays operating expenses, the operator would begin to shut down the facilities. In a typical situation, wells would be permanently plugged with cement and wellhead equipment removed. Processing modules would be moved off the platforms. Pipelines would be decommissioned by cleaning the pipeline, plugging both ends, and leaving it in place buried in the seabed. The overland oil and gas pipelines are likely to be used by other fields in the NPR-A and would remain in operation. Lastly, the platform would be disassembled and removed from the area and the seafloor site would be cleared of all obstructions. Post abandonment surveys would be required to confirm that no debris remains following decommissioning and that pipelines were decommissioned properly.

Drilling Wastes

Geologic studies indicate that exploration wells usually test prospects from 3,000-15,000 ft (914-4,572 m) in the subsurface. Based on the characteristics of the geologic plays, BOEM assumes that vertical exploration wells would average 8,000 ft (2,438 m) deep. Production and service wells are assumed to average 10,000 ft (3,048 m)(measured depth), because they would include deviated wells, which are not perfectly vertical.

For the assumed drilling depths, an average exploration well would produce 600 tons of dry rock cuttings. Synthetic drilling fluids are now commonly used on the deeper intermediate and production sections of wells. BOEM assumes that the synthetic drilling mud would be reconditioned and reused with efficiency of 80%. For exploration wells, rock cuttings would be discharged at the exploration site. However, the waste products (i.e., drilling mud, rock cuttings, and produced water) for platform (production) wells would be treated and then disposed of in service wells on the production platforms. For the outlying subsea wells, drilling waste products could be barged to the coastal facility for treatment and disposal.

Well operations use a variety of drilling fluids, each with a different composition. The type of drilling fluid used depends on its availability, the geologic conditions, and experiences of the drilling contractor. Often, several different types of drilling fluids are used in a single well and most of the drilling fluids are recycled (80%). BOEM assumes that the discharged drilling fluid used for drilling the shallowest part of the well would be a common water-base mud of the generic composition shown below. Fluid discharges are regulated by Federal and state agencies.

General Composition of Drilling Mud. Drilling mud used in this Scenario may include the following components in varying proportions:

- Bentonite
- Lignosulfonate
- Lignite
- Caustic
- Lime
- Barite
- Drilled solids
- Soda ash/Sodium Bicarbonate
- Cellulose Polymer
- Seawater/Freshwater as needed

2.4. Monitoring and Environmental Studies

BOEM's Environmental Studies Program (ESP) actively plans, designs, and manages robust scientific research specifically to inform decisions regarding development of OCS energy and mineral resources. Research covers physical, biological, and chemical oceanography, atmospheric sciences, oil-spill extent and effects, protected species, socio-economics, cultural resources, and documentation of local and traditional knowledge systems. The broad spectrum of research and monitoring undertaken through the ESP contributes to the BOEM mission and long-term DOI goals focusing on environmentally sound development of our Nation's energy and mineral resources. The ESP is managed in a way to maximize cooperative efforts with other Federal programs involved with marine and coastal environmental research and data collection, including inter-agency agreements, cooperative agreements, and competitive contracts. BOEM research has consistently been recognized for excellence in effective collaboration through venues such as the DOI Partners in Conservation Awards and the National Oceanographic Partnership Program Excellence Awards.

The ESP was initiated in 1973 to support the U.S. Department of the Interior's OCS oil and gas leasing program. Statutory authorization is derived primarily from the OCSLA, as amended, and NEPA. Section 20 of the OCSLA authorizes the ESP and establishes three general goals for the program:

1. To establish the information needed for assessment and management of environmental impacts on the human, marine, and coastal environments of the OCS and the potentially affected coastal areas.
2. To predict impacts on the marine biota which may result from chronic, low-level pollution or large oil spills associated with OCS production, from drilling fluids and cuttings discharges, pipeline emplacement, or onshore facilities.
3. To monitor human, marine, and coastal environments to provide time series and data trend information for identification of significant changes in the quality and productivity of these environments, and to identify the causes of these changes.

Since 1973, BOEM has invested about $450 million studying the OCS environment offshore in Alaska, and completed more than 1000 technical reports/publications. The studies have led to mitigation measures to protect OCS areas and resources, increased knowledge of the marine, coastal, and human environments; and provided long-term monitoring of the effects of OCS oil and gas activity. Information on BOEM's Environmental Studies Program specific to the Alaska Region is at http://www.boem.gov/akstudies/.

Some notable recently completed BOEM technical reports include, but are not limited to, the following:

- Aggregate Effects of Oil and Gas Operations on Iñupiaq Subsistence (OCS Study BOEM 2013-212)
- Chukchi Sea Offshore Monitoring in Drilling Area (COMIDA): Impact Monitoring for Offshore Subsistence Hunting, Wainwright and Point Lay, Alaska (OCS Study BOEM 2013-0211)
- Monitoring Cross Island Whaling Activities, Beaufort Sea, Alaska: 2008-2012 Final Report, Incorporating Arctic Nearshore Impact Monitoring in the Development Area (ANIMIDA) and cANIMIDA (2001-2007) (OCS Study BOEM 2013-0218)
- Oil-Spill Occurrence Rates for Alaska North Slope Crude and Refined Oil Spills (OCS Study BOEM 2013-0205)
- Beaufort and Chukchi Seas Mesoscale Meteorology Study (OCS Study BOEM 2013-0119)
- Distribution and Relative Abundance of Marine Mammals in the Northeastern Chukchi and Western Beaufort Seas, 2012 (OCS Study BOEM 2013-0117): Annual Report

- Bowhead Whale Feeding Ecology Study (BOWFEST) in the Western Beaufort Sea (OCS Study BOEM 2013-0114)
- Chukchi Sea Offshore Monitoring in Drilling Area (COMIDA): Chemical Benthos (OCS Study BOEM 2013-012)
- Satellite Tracking of Bowhead Whales (OCS Study BOEM 2013-110)
- Synthesis: Three Decades of Research on Socioeconomic Effects Related to Offshore Petroleum Development in Coastal Alaska (OCS Study BOEM 2009-006)

2.5. Summary of Environmental Impacts

This section briefly summarizes the environmental impacts that could occur under the four alternatives outlined in Section 2.1.1. These summaries are based on the analysis provided in Section 4.3. Summaries are presented by alternative, and for each resource area potentially affected under that alternative.

The terms "negligible," "minor," "moderate," and "major" used below are derived from the Impacts Scale defined in Section 4.2 of this document.

2.5.1. Summary of Impacts: Alternative I – Proposed Action

Water Quality

Considering effects on water resources from all activities in Years 1-77, the impacts on water quality from routine oil and gas activities associated from the Scenario would be minor because potential adverse effects would be localized and short-term. In the event of one or more large oil spills, effects would be moderate because they could be widespread, and long-lasting.

Air Quality

The impacts of the Scenario on air quality are expected to be minor for all routine activities associated with the Scenario, but the potential impacts from large oil spills could be moderate.

Climate Change

The exploration, development and production activities under the Scenario would produce greenhouse gas (GHG) emissions and particulate matter (PM) that would contribute to climate change. However, the GHG and PM emissions from the Scenario would be small relative to global GHG and PM emissions, and therefore, the contribution of the Scenario to global climate change would be negligible.

Lower Trophic Organisms

The impacts of all routine activities in the Scenario on lower trophic level organisms are expected to be moderate over the life of the Scenario. This is due to the resiliency and reproductive capability of the organisms. The potential impacts from large spills are expected to be moderate due to the persistence of oil in tidal and sub-tidal sediments.

Fish

Considering all time periods from years 1-77, and all types of effects from the activities during these time periods (including two large oil spills between Years 10-74), the impacts on fish from routine oil and gas activities from the Scenario would be minor. Although mortality of individuals would occur, and there could be potential introduction of invasive species, the effects on fish would be localized and short-term. In the event of a large oil spill, effects would be moderate because they would be widespread, long-lasting, mortality of individuals would occur, and there would be potential for introduction of invasive species.

Marine and Coastal Birds

The potential level of mortality to marine and coastal birds, combined with habitat loss and long-term disturbances from pipeline corridor maintenance from the Scenario over the life of the Scenario are anticipated to result in major impacts on marine and coastal birds. The impacts are expected to have long-lasting changes in the resource's function in the ecosystem.

Marine Mammals

The impacts of the Scenario on marine mammals are expected to range from negligible to moderate for all routine activities associated with the Scenario, depending on the species, nature and timing of activities. The potential impacts from large oil spills could range from negligible to major.

Terrestrial Mammals

The impacts of routine activities in the Scenario on terrestrial mammals such as caribou and muskoxen would be moderate due to disturbance from noise, vehicle and human presence, and other activities. The impacts of potential large oil spills in the Chukchi Sea on terrestrial mammals would negligible to minor.

Vegetation and Wetlands

The impacts of routine activities in the Scenario on vegetation and wetlands are expected to range from negligible to minor, due to short-term, localized effects on ecological functions, species abundance and composition of wetlands and plant communities. The potential impacts from large oil spills would range from minor to moderate, depending the location and effectiveness of response measures.

Economy

The impacts of the Scenario on the economy are expected to be major, as the Scenario would cause long-lasting and widespread increases in employment and labor income over many years.

Subsistence-Harvest Patterns

The impacts of the Scenario on subsistence-harvest patterns are expected to be major at various times over the course of the 77-year Scenario. This is due to disruptions in subsistence hunting from degradation of subsistence resources and use areas. Actual or perceived tainting from potential large oil spills could render resources unavailable or undesirable for use, which would result in a major impact.

Sociocultural Systems

The impacts of the Scenario on sociocultural systems could be up to major depending on the phase of the activity. When subsistence-harvest patterns are adversely affected, sociocultural systems can in turn be impacted. Subsistence-harvest patterns can be disrupted from routine activities during the Scenario or large oil spills.

Public and Community Health

The impacts of the Scenario on public and community health could be up to major depending on the phase and nature of the activity. These impacts are closely related to impacts on subsistence-harvest patterns and sociocultural systems.

Environmental Justice (EJ)

Anticipated effects from the Scenario to EJ would be up to major, depending on the phase and nature of the activities. The phases with the most overlapping activities and highest probability of spills would cause the most impact to subsistence-harvest patterns and thus the highest level of EJ impacts.

Archaeological Resources

Anticipated impacts to historic and prehistoric archaeological resources from the Scenario would be major, given that historic and archaeological resources would be present, difficult to identify, and directly affected by activities described in this section. The amount of ground disturbance, both on- and offshore, would be of a large magnitude and a long duration. This impact assessment is not altered in the event of a 5,500 or 1,700 bbl oil spill.

2.5.2. Summary of Impacts: Alternative II – No Lease Sale

Under the No Action Alternative (Alternative II), the Secretary would decline to affirm Lease Sale 193, and would instead vacate the leases. Selection of this alternative would effectively eliminate the possibility for OCS oil and gas development and production as a result of Lease 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 (lease rentals, taxes, royalties on production) would not be realized from Lease Sale 193. The selection of this alternative would also postpone potential contributions to national energy supplies delivered through the TAPS. This key pipeline system provides energy security to the nation and 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.

2.5.3. Summary of Impacts: Alternative III – Corridor I Deferral

The effects of Alternative III are based on the application of the same Scenario as analyzed under Alternative I. Using the Impacts Scale in Section 4.2, the level of expected impacts under Alternative III are consistent with the levels of expected impacts described under Alternative I. Nevertheless, the larger deferral area could result in differences in some impacts between Alternatives III and I due to the greater distance of many Scenario activities from shore, subsistence use areas and important environmental resource areas. The removal of landward lease blocks within the deferral could increase the time for hypothetical oil spills to contact land and nearshore areas and reduce the chance of one or more large spills occurring and contacting (2007 FEIS, Appendix A Tables A.2-79 through A.2-90).

2.5.4. Summary of Impacts: Alternative IV – Corridor II Deferral

Impacts under this alternative would be the same as described for Alternative I – Proposed Action.

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Description of the Environment

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Chapter 3. DESCRIPTION OF THE ENVIRONMENT

The following sections in this chapter describe the physical, biological, and socioeconomic conditions and resources that could be affected by the Proposed Action and the alternatives. Important background and other information for these sections is contained in the 2007 FEIS (Chapter III) the 2011 SEIS (Chapter III), and the 2011 SEIS (Appendix A, Analysis of Incomplete or Missing Information). This chapter summarizes information from the 2007 FEIS and the 2011 SEIS as appropriate and provides additional information relevant to understanding potential effects from the expanded Scenario, particularly information that became available after the publication of the 2011 SEIS.

3.1. Physical Environment

In addition to information in the 2007 FEIS and 2011 SEIS, portions of several recent national and global assessments which encompass the Arctic are also relevant to the description of the physical environment in the Chukchi Sea (Table 3-1). These reports illustrate a consistent pattern of climate-driven environmental changes in the Arctic region, including the Chukchi Sea Leased Area, in recent decades.

Table 3-1. National and Global Assessments: Chukchi Sea Physical Environment Changes.

In Text Citation	Report Name	Chapter(s) and Title	Section(s)
AMAP, 2011a	Snow, Water, Ice and Permafrost in the Arctic	9. Sea Ice	9.1, 9.2, 9.3.1, 9.3.2
AMAP, 2011b	Mercury in the Arctic.	N/A	All
AMAP, 2013	AMAP Assessment 2013: Arctic Ocean Acidification	1. The sensitivity of the Arctic Ocean to acidification, 2. Acidification in the Arctic Ocean	1.3.1, 2.1-2.3, 2.5.2.2
Arctic Council, 2013a	Arctic Resilience Interim Report 2013	4. Thresholds in the Arctic	4.3
Forbes, 2011	State of the Arctic Coast 2010	2. State of the Arctic Coast 2010 – A Thematic Assessment	2.1
IPCC, 2013a	Climate Change 2013: The Physical Science Basis	3. Observations: Oceans, 4. Observations: Sea Ice	3.3.3, 4.2.2
Melillo, Richmond, and Yohe. 2014	Climate Change Impacts in the United States	22. Arctic	All

3.1.1. Bathymetry and Physiography

The Chukchi Sea is a marginal sea of the Arctic Ocean located north and west of the U.S. Arctic coast. The Leased Area overlies a broad, low-relief continental shelf that is gently inclined to the north. Approximately 98% of the Leased Area covers this relatively shallow continental shelf adjacent to the Arctic Ocean (Figure 3-1). Water depths within the Leased Area range from approximately 30 to 50 m (~98 to 164 ft). Nearshore areas (shallower than 40 m (131 ft)) exhibit complex bathymetry characterized by ridges and troughs. Hanna Shoal and Herald Shoal rise above the surrounding seafloor to approximately 20 m (66 ft) below sea level. There are also two major sea valleys in the Chukchi Sea: Herald Canyon and Barrow Canyon (Figures 3-1 and 3-3). The Barrow Sea Valley begins north of Wainwright and trends in a northeasterly direction parallel to the Alaskan coast. Herald Valley is to the north adjacent to Wrangel Island, outside the Leased Area. Hope Valley, a broad depression, stretches from Bering Strait to Herald Canyon. These topographic features exert a steering effect on the oceanographic circulation patterns in this area.

The shoreline west of Barrow is characterized by nearly continuous sea cliffs up to 12 m (40 ft) high 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 ACP is flat near the coast, and gradually increases in relief to the south towards the foothills of the Brooks Range. The Arctic Coastal Plain (ACP) of northern Alaska is a complex landscape of lakes, streams, and wetlands scattered across low relief tundra that is underlain by permafrost. This region of the Arctic has experienced a warming trend over the past three decades, leading to thawing of onshore permafrost. Reduction in sea ice duration and extent has increased ocean wave action, leading to higher rates of erosion and salt water inundation of coastal habitats (Forbes, 2011; Tape et al., 2013).

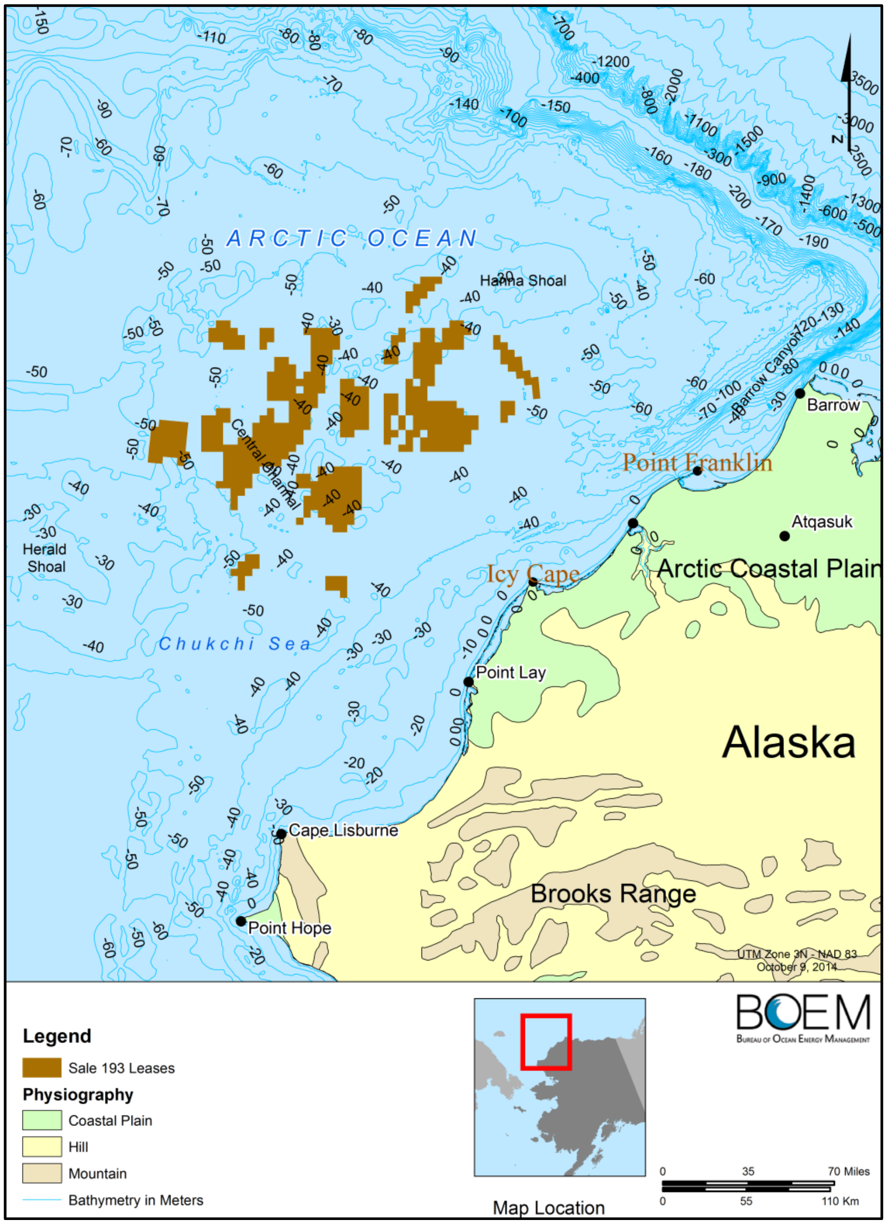

Figure 3-1. Bathymetry and Physiography. *Figure 3-1 displays the bathymetry and physiography in and adjacent to the 2007-2012 Chukchi Sea Program Area.*

3.1.2. Climate and Weather Conditions on the North Slope

The difference between climate and weather is a measure of time. Weather provides the condition of the lower atmosphere over a short period of time (hours to weeks), and climate describes how the atmosphere behaves over relatively long periods of time, generally averaged over 30 years or more. Meteorology is the scientific study of the Earth's atmosphere, particularly patterns of climate and weather.

3.1.2.1. Climate Classifications

Land areas can be classified according to averages of meteorological and geographical variables, such as latitudes, origin of air masses, proximity of water bodies, topography, temperature, and precipitation. Land areas having similar measures of these variables can be classified as zones, and a map of zones across the world, such as the one developed by Wladimir Köppen (Ahrens, 2013), can be charted. While the weather within each zone is variable to some degree, the average weather over time reflects the entire zone (Shulski and Wendler, 2007). The U.S. Geological Survey (USGS) divides the State of Alaska into four climate zones. Figure 3-2 (USGS, 2009) shows a map of Alaska Climate Zones.

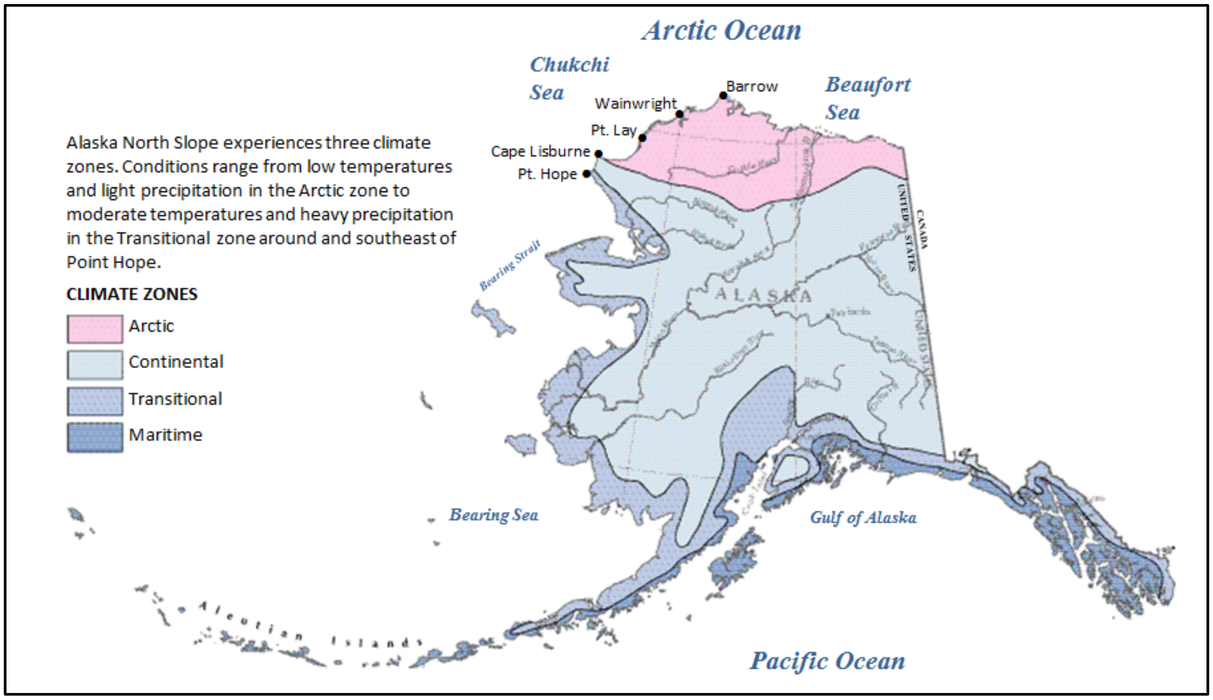

Figure 3-2. Alaska Climatic Zones. *The Arctic (polar tundra), Continental, and Transitional (subpolar) Climate Zones of the Alaska North Slope. Source: USGS (2009).*

The northernmost portion of the Alaska North Slope, identified as the Arctic climate zone, is characterized as a polar tundra climate according to the Köppen classification system. Classification as a polar tundra climate suggests cool short summers, extremely cold long winters, and little precipitation.

South of the Arctic Zone is an area of greater precipitation and slightly warmer temperatures—the Continental Zone. This zone covers much of central Alaska and is characterized by warmer temperatures, greater precipitation, and a more variable wind direction, probably due to the decreasing influence of the Brooks Range to the west (see Figure 3-1 and a description of the Brooks Range under Wind Direction and Speed, below). The small area of the Transitional Zone on the North Slope is located around Point Hope and lies south along most of the western coastlines. There is little perceptible difference between the Continental and Transitional Zones other than the prevailing wind. The Continental and Transitional zones are described by Köppen as subpolar climates (Ahrens, 2013).

Temperatures

The average monthly temperatures at all the locations evaluated for this section are cold in the winter and cool in the summer. The temperatures tend to decrease rapidly beginning in the autumn months and begin increasing again in the late spring. When comparing locations along the western Alaska

North Slope coast, temperatures generally increase steadily from Barrow south to Point Lay, and then increase sharply further south near Point Hope. This is consistent, because the climate zones shift from Arctic, to Continental, to Transitional. For most of the stations, the warmest month is July, but moves to August in the Transitional Zone at Point Hope. A summary of the temperature statistics of the western North Slope is provided in Table 3-2.

Table 3-2. Average Temperature Data.

Cities and Towns on the Alaska Western North Slope	Average Temperatures (°F)			Warmest Month (°F)			
	Highest Month	Lowest Month	Annual Average	Month	Average High	Average Low	Average Temperature
Barrow	15.5	4.8	10.2	July	45.6	33.8	39.7
Wainwright	17.0	4.4	10.7	July	49.5	35.8	42.7
Point Lay	19.2	6.2	12.7	July	51.6	38.5	45.1
Cape Lisburne	21.9	13.1	17.5	July	49.8	40.5	45.2
Point Hope	25.2	16.7	21.0	Aug	51.0	44.0	47.5

Sources: Western Region Climate Center (WRCC), 2014; Point Hope data: Weatherspark, 2014.

Precipitation

The average annual precipitation increases steadily from Barrow, Alaska, south to Point Lay, and then nearly doubles when entering the Continental Zone near Cape Lisburne. Most precipitation falls in August along the coast; the least amount of precipitation in the winter and early spring. A summary of the precipitation statistics of the western North Slope is provided in Table 3-3.

Table 3-3. Average Precipitation Data.

Cities and Towns on the Alaska Western North Slope	Month of Most Average Precipitation	Month of Least Average Precipitation	Annual Average Precipitation (inches)
Barrow	August	March	4.6 (11.7 cm)
Wainwright	August	February	6.5 (16.5 cm)
Point Lay	August	February	5.7 (14.5 cm)
Cape Lisburne	August	March	11.3 (28.7 cm)

Source: WRCC, 2014.

Wind Direction and Speed

A multiyear meteorological study that includes data from stations along the Beaufort Sea coastline at Barter Island, Kaktovik, Deadhorse, and Nuiqsut, Alaska, suggests the trend for wind patterns on the North Slope are influenced by the Brooks Range (Veltkamp and Wilcox, 2007). The study shows that regardless of whether the winds are from the east or west, the flow over the eastern portion of the Beaufort Sea coastline is influenced by the Brooks Range, which can affect wind direction as far as 30 miles (mi) (48.3 km) offshore. The incidence of wind channeling is strongest on the eastern coastline near Barter Island, east of Prudhoe Bay. Influence from the mountain range decreases to the west and shows little impact west of Barrow where wind direction in the Chukchi Sea is influenced more by surface pressure systems. The Brooks Mountain Range is situated in a generally west to east direction with peaks of 5,000 to 9,000 feet (ft) (1,524 2,743 m in the east, dropping off to 1,500 to 3,000 ft (457-914 m) peaks in the west.

Annual average prevailing winds from Barrow, Alaska, southwest to Point Lay are generally from the east-northeast, changing to the southeast at Cape Lisburne, and turning north at Point Hope. Along this path, the speed of the prevailing wind increases from 5.5 meters per second (m/s) (12.3 miles per hour (mph)) to 6.7 m/s (15 mph). The wind is stronger in the winter than the summer, when winds are lowest. A summary of the prevailing winds on an annual, monthly, and seasonal basis is provided in Table 3-4.

Table 3-4. Prevailing Winds.

Cities and Towns on the Alaska Western North Slope	Prevailing Wind					
	Annual Average		Monthly Average		Seasonal Average	
	Direction	Speed (m/s)	Average High Wind Month	Average Calm Wind Month	Summer	Winter
Barrow	E-NE	5.5	October	June	E	NE
Wainwright	E	5.0	January	June	E and W	E
Point Lay	E-NE	5.7	December	June	NE	NE
Cape Lisburne	SE	5.3	October	June	SE and SW	SE
Point Hope	N	6.7	October	June	N and S	NE

Source: Alaska Energy Authority, 2013.

3.1.2.2. Cloudiness and Relative Humidity

Cloudiness prevails year-round on the western North Slope, from Barrow to Point Hope. The average cloud cover is greater than 50% from April through December. Relative humidity ranges from 74% in the winter to 90% in the summer. The highest humidity readings along the coastline of the Western North Slope occur in Barrow, Alaska, decreasing to the south, to the lowest readings in Point Hope (Weatherspark, 2014).

3.1.2.3. Surface Pressure Centers

During the summer months of ice-free water, the influence of maritime polar air masses on the western North Slope is greatest and the ocean has a moderating influence, resulting in higher temperatures in the winter and lower temperatures in the summer than the inland areas of Alaska. This is due to the semi-permanent area of low pressure referred to as the Aleutian Low (Shulski, Hartmann, and Wendler, 2003). The center has less effect in the summer, tending to intensify through the autumn months. This accounts for the considerable drop in mean monthly temperatures from August to October that affects the western North Slope.

3.1.2.4. Solar Radiation

Probably the most unique climate feature of the Alaska North Slope is the extreme seasonal variation in the amount of solar radiation (Shulski and Wendler, 2007). The sun will rise in Barrow on May 10 and will not set again until August 2. When the sun sets on November 18, it will not rise again until January 22. Southwest of Barrow, fewer hours of constant sunlight and darkness occur in Point Hope where the sun will rise on May 24 and set on July 19, setting finally on December 5 and not rising again until January 6. Summer days mean constant sunlight, though this does not translate to any periods of intense heat. Sunlight is also reflected by snow and ice, reducing the amount of solar radiation absorbed by the ground (U.S. Navy, 2014).

3.1.3. Physical Oceanography

The physical oceanography in the Leased Area is influenced by:

1. Flow of water through the Bering Strait
2. Atmospheric-pressure systems
3. Surface-water runoff
4. Density differences between water masses
5. Seasonal and perennial sea ice

The mean water flow in the Leased Area is generally northward from the Bering Strait and, in general, is topographically steered (Figure 3-3). Variability in the mean flow is primarily caused by winds which can reverse the direction of flow. Flow variations can be large (Weingartner et al., 1998;

Woodgate, Aagaard, and Weingartner, 2005). The general cycle of the water masses is cooling in the fall, increasing salinity in winter, and warming and freshening starting in the Arctic spring and continuing into summer. Large changes in temperature and salinity occur throughout the year, with the largest variability along the Alaskan Chukchi Sea coast. Tides are small in the Chukchi Sea, generally <0.3 m (1 ft). Tidal currents are largest on the western side of the Chukchi Sea and near Wrangel Island, ranging up to 5 centimeters per second (cm/s) (0.09 knots (kts)) (USDOI, MMS, 2007a; Woodgate, Aagaard, and Weingartner, 2005). Storm surges are both positive and negative with highest levels in August and lowest levels in March (Gill et al., 2011).

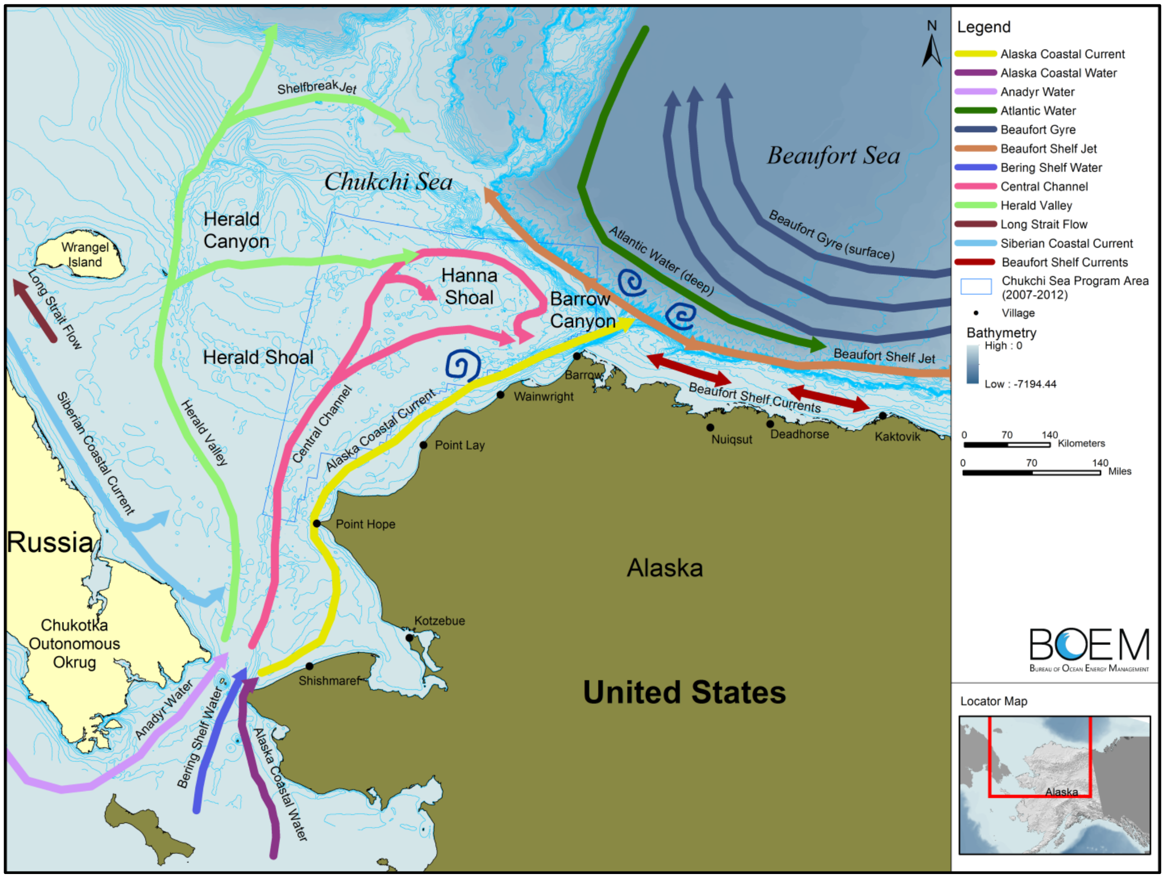

Figure 3-3. Generalized Current Circulation over the Chukchi and Beaufort Seas. *Source: Modified from Weingartner et al. (2013a).*

Federal, State, and private entities, in concert and separately, have funded several large oceanographic programs in the Chukchi Sea specifically to study the oceanography in and around the Leased Area. From 2008 to 2011, under the Chukchi Sea Environmental Studies Program (CSESP), the Chukchi Sea Leased Area has been studied in detail every year (Weingartner et al., 2010, 2011, 2012, 2013a). From 2009-2011, the circulation of the northeast Chukchi Sea was studied using HF Radar, gliders and moorings (Weingartner et al., 2013b). From 2012-2016, a follow up to this study is looking at the physical oceanography of the northeast Chukchi Sea Shelf and exchanges between the northeast Chukchi Sea and the western Beaufort Sea Shelves and the adjacent basin (Weingartner, 2013). During 2012-2014, one component of the Hanna Shoal Ecosystem Study investigates the oceanography around the Hanna Shoal area (Grebmeier, 2012a; Cooper, 2013; Dunton, 2013). Many of the general oceanographic circulation patterns and water properties previously described remain the same. However, these observational programs provide refined details about the circulation and water properties or verify modeling results which were previously used to infer information about circulation or upwelling.

Circulation

Recent observations have confirmed several features that were previously inferred from modeling results. Verified circulation features include:

- The mean water movement (northeast) through the central Chukchi Sea Shelf
- Measurements of sea current speed and direction (clockwise) around Hanna Shoal
- The (increasing) volume of flow within Bering Strait and Barrow Canyon

These features are further discussed below. Additionally, local and indigenous (traditional) knowledge provides information for describing the nearshore environment across all seasons (Johnson et al., 2014):

> Multiple currents influence local navigation 15, 20, or more miles (24-32 km) out from the coast. The currents are described as "stacked," with transition zones at one mile (1.6 km), 2-3 mi (3.2-4.8 km), 5-7 mi (8-11.3 km), and farther offshore. For the region between Barrow and Peard Bay, there are four to five stacked currents with the current width increasing offshore. Farther offshore of Barrow the "current from Point Franklin" is between seven [miles] (11.3 km) and 12 to 20 miles (19.3-32.2 km) out. The current width is five to -15 miles (8 24.1 km). A third current is about six miles (9.7 km) wide. The fourth current is over 30 miles (48.3 km) out. The currents strengthen from Wainwright to Barrow. The water gets “clear” four to five miles (6.4-8 km) out from Barrow, marking the “open waterway” with less ice during the ice season.
>
> Early in the open water season, July 1 to mid-August, generally a period of relative calm, there is often a visible surface streak of foam and algae in the shear or transition zones marking currents of differing velocities. Later in the season, the surface condition becomes well-mixed from wind and storm events, making it harder to see the current transition zones.
>
> Off Point Barrow, the main current can flow toward the east, north, or northwest depending on season and weather. The current pattern was compared to a three-way intersection. The northeast flowing current generally turns east at Point Barrow and/or to the north-northwest toward deeper water. Eastward flow around Point Barrow is confirmed by boats that have drifted in surface currents from Peard Bay to Point Barrow and to Lonely, AK. Reversals in the coastal current can occur daily, and are more commonly observed in winter. By April/May the current becomes steady to the northeast with an average speed of one to two knots (Johnson et al., 2014).

High-frequency radar surface current mapping provides detailed information on current direction and speed. Along with glider and mooring data, it also provides insights on the variability and structure of the circulation field at high resolution as shown in Figure 3-4 (Weingartner et al., 2013b; Potter et al., 2014). Within 35 km (24 mi) of the coast, the Alaska Coastal current speeds range from approximately 30 50 cm/s (0.58-0.97 kts) (and farther offshore are approximately 10 cm/s (0.19 kts). The circulation moves generally eastward across the central Chukchi Sea Shelf with reversals occurring for Northeast winds of speeds greater than 6 cm/s (0.12 kts). During the open water period, this eastward flow splits with some water entering Barrow Canyon and some moving southwestward towards Icy Cape at least as far south as Point Lay. Figure 3-4 shows that current speeds are much faster for Barrow Canyon flow when the mean flow is southwestward.

Current patterns may consist of transitory mesoscale circulation features, including eddies with diameters of approximately 20 km (12 mi). These eddies appear most frequently at the head of

Barrow Canyon and to the east of Hanna Shoal (Weingartner et al., 2013b). At the northeast Chukchi Sea Shelf break, Kawaguchi, Itoh and Nishino (2012) documented a large warm anticyclonic (moves clockwise) eddy. The eddy was 60-70 km (37-43 mi) in diameter, and was much larger than eddies previously reported. The eddy likely originated at the Chukchi Sea shelf and was then carried by the westward jet in the Beaufort Sea.

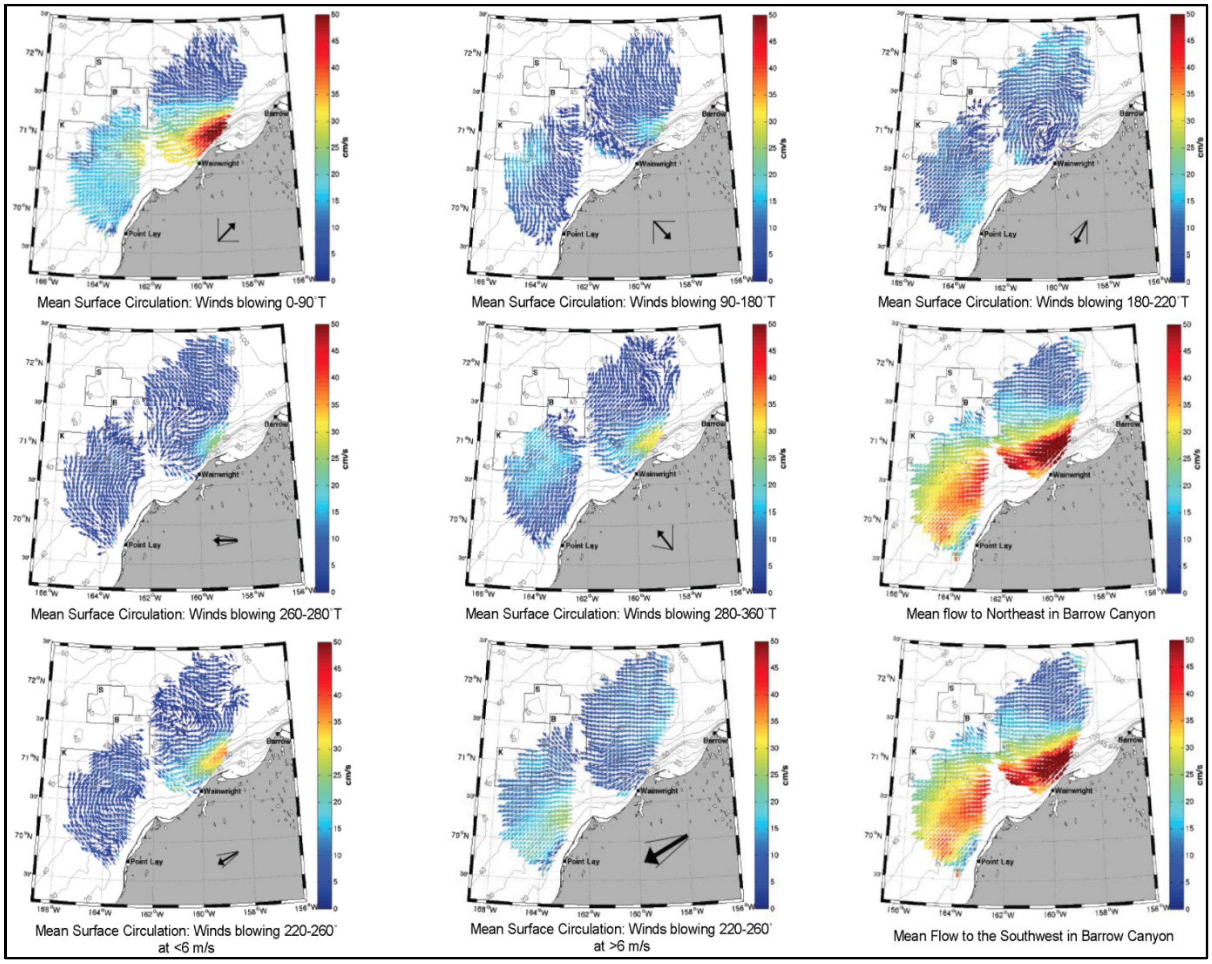

Figure 3-4. Ocean Surface Currents in Response to Changing Winds. *Images display high-frequency radar observations showing surface current variability in response to changing wind directions and speed. Source: Potter et al., (2014).*

Flow around Hanna Shoal was inferred as a clockwise circulation (Spall, 2007), supported later by a one-year set of oceanographic data (Dunton, 2013). Northward flowing waters turned eastward north of Hanna Shoal (Weingartner et al., 2013a) and then flowed southward along the eastern flank of Hanna Shoal (Dunton, 2013; Weingartner et al., 2013a). Directly south of the shoal the flow is eastward. Average flow speeds around Hanna Shoal are about 20 cm/s (0.39 kts).

Upwelling

Upwelling brings nutrient rich waters from depth to shallow waters, usually as a result of divergent currents. The upwelled nutrients provide for plankton blooms and these locations often become feeding areas for higher trophic organisms. The divergence identified between Wainwright and Icy Cape likely results in upwelling inshore of 30 meters (98 ft) water depth (Weingartner et al., 2013b). Recently, near surface winds have trended to a more northeasterly direction. These winds are favorable to upwelling along the northern Chukchi Sea shelf and are thought to drive large under ice-plankton blooms during thin ice periods (Spall et al., 2014).

Temperature and Salinity

The Leased Area has large interannual temperature and salinity variations largely dependent on the processes occurring in the Bering and/or southern Chukchi Sea (Weingartner et al., 2013a; Danielson et al., 2014).

Temperature and salinity vary throughout the Arctic summer season and can change over short gradients of 50 to 100 km (31-62 mi) within the Leased Area.

High resolution glider sampling of temperature and salinity has shown even finer scale density variability and surface stratification (Timmermans and Winsor, 2013). From May through August a strongly stratified water column moves gradually north and is replaced by warm Bering Sea water advected eastward from the central channel (Day et al., 2013; Weingartner et al., 2013a, 2013b). This stratified water column consists of a layer of fresh and cold (light) melt water from retreating sea ice which sits over a layer of salty and cold (dense) water formed over the winter.

Weingartner et al. (2013a) discuss water properties in the Burger, Klondike and Statoil study areas. The temperature and salinity in the Burger area are generally quite different from those at Klondike and Statoil. The Burger area generally consists of more meltwater and the dense cold winter water persists for much longer. Different water masses reside at Burger in the surface and at depth, with surface meltwater from Hanna Shoal advecting from the north. Biological differences between the Burger, Statoil and Klondike study areas may be due to the variations in temperature and salinity, stratification and the circulation dynamics.

Detailed measurements of temperature and salinity around Hanna Shoal show meltwater and winter water are found everywhere and Bering Shelf Water and Alaska Coastal Water were found primarily within stations in Barrow Canyon (Dunton, 2013).

Bering Strait and Barrow Canyon Flow

The flow through Bering Strait provides heat, freshwater, and nutrients to the Chukchi Sea shelf. The Bering Strait flow increased approximately 50% from 2001 to 2011. Measurements indicate an increase from about 0.7 Sverdrups (Sv) to about 1.1 Sv (a Sverdrup is a unit of volume transport equal to 1,000,000 cubic meters per second (m^3/sec) (Woodgate, Weingartner, and Lindsay, 2012). The increase in flow drives heat and freshwater increases (Woodgate, Weingartner, and Lindsay, 2012) which have a large impact on the water column in the Chukchi Sea and melts sea ice. About two-thirds of the increase was explained by changes in pressure differences between the Arctic and the Pacific, and the rest was attributed to local winds.

Barrow Canyon is a major conduit for Pacific waters, which cross the Chukchi Sea shelf area to enter the Canada Basin. Weingartner et al. (2013b) present a highly resolved estimate of mean Barrow Canyon annual transport of approximately 0.3 Sv. This transport volume is approximately 40% of the flow through the Bering Strait. Additional flow may enter north of the current meter moorings which were used to constrain these estimates (Weingartner et al., 2013a, b). Itoh et al. (2013) estimated total Barrow Canyon flow was 0.45 Sv, which consisted of 0.44 Sv of Pacific water and 0.1 Sv Atlantic Water.

Waters flow both up and down Barrow Canyon and variations in canyon transport are correlated to local wind. Properties of the system change through time and they appear to correlate through time to the wind. This suggests transport may respond to wind forcing over the southern Chukchi and northern Bering Sea, with up canyon typical speeds of 50 cm/s (0.97 kts). Several up canyon events lasted ten days, spreading slope waters over a large portion of the Chukchi Sea shelf before draining back down the canyon.

Waves

Weingartner et al. (2013b) describe wave measurements in the Chukchi Sea. The wave field consists mostly of waves at 4-8 second periods with a significant wave height of approximately 1-2 m (3-6 ft). Waves come mainly from the north, northeast, and northwest. The largest waves were from the northwest at about 4 m (13 ft) wave height. Thompson and Rogers (2014) modeling data agree with the largest wave heights discussed by Weingartner et al. (2013b) and suggest that future reductions in seasonal ice cover could generate larger waves and swells.

3.1.4. Sea Ice

There are three general forms of sea ice in or adjacent to the Leased Area:

- **Landfast ice.** Relatively immobile ice attached to the shore, extending to variable distances offshore.
- **Stamukhi ice.** Grounded and ridged ice that remains attached to the ocean bottom into the summer.
- **Pack ice.** 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 Leased Area and are strongly influenced by the bathymetry and location of offshore shoals as well as atmospheric-pressure fields. There is a large amount of interannual variability in the formation and breakup patterns of sea ice.

In the Leased Area, sea-ice extent has a large seasonal cycle, generally reaching a maximum extent in March and a minimum in September. Sea ice generally begins forming in late September or early October, covering most of the Leased Area by mid-November or the beginning of December. The summer melt pattern is primarily influenced by the influx of warmer water from the Bering Sea. Melt-onset begins in early May in the southern portion of the Leased 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 Sea is normally 80% free of ice. Freeze onset begins in mid- to late October in the southern portion and late September to late October in the northern portion.

Arctic sea ice is undergoing changes in extent, thickness, distribution, age, and melt duration. 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, Stamukhi, and Pack-Ice Zones

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 (6.6 ft) 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.

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).

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 Program 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.

Chukchi Sea Polynya 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. Polynyas generally 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 polynya system is about 4 km (2.5 mi) at the northern end (toward Barrow) but widens to about 100 km (62 mi) at the southern end (toward Point Hope). General locations for polynyas in this region are illustrated in the 2007 FEIS (Figure III.A-14).

Ice Gouging

At depths shallower than 60 m (197 ft), 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 (7.9 ft) at 12 m (39 ft) of water depth to 2.8 m (9.2 ft) at 24 m (79 ft) of water depth. Below 28–30 m (92-98 ft), 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 (141 ft) deep. In the central part of the Leased Area, ice gouges were observed cutting across sand-ripple fields that may be active under present-day current regimes. Recent gouges as deep as 4 m (13 ft) have been identified (Coastal Frontiers, 2012).

Other Information

Sea ice is a physical state of water that becomes a part of the ecosystem from both a biological and a sociocultural perspective. Sea ice plays a role in terms of structuring the environment by influencing productivity, species interactions, population mixing, gene flow, and pathogen and disease transmission (Meier et al., 2011; Post et al., 2013). Landfast ice is used as a pathway for travel and as a platform for hunting, fishing, and whaling for many indigenous communities (Druckenmiller et al., 2013; SRB&A, 2013). Sea ice in and adjacent to the Leased Area is changing. The loss of sea ice represents habitat loss for ice-adapted species including seals, polar bears, walrus, fish, beluga and bowhead whales, primary producers and some microbial communities (Kovacs et al., 2011; Meier et al., 2011). Melting sea ice may also be a source of contaminants to the environment. Recently, Obbard et al. (2014) identified the increased release of microplastics from melting sea ice at concentrations two times those of the Pacific gyre.

The most visible change over the last three decades has been the reduction in summer sea-ice extent and thickness (Comiso, 2012; NSIDC, 2014c; Parkinson and Comiso, 2013). The decreasing trend in extent is observed in all seasons. Figure 3-5 shows the maximum ice extent in March of 2014, and the minimum ice extent in September of 2014. Satellite data have shown that Arctic March sea-ice extent has decreased by about 2.6% per decade from 1979 through 2014, relative to the 1981 to 2010 average (NSIDC, 2014c). Through 2014, the September linear rate of decline is 13.3% per decade relative to the 1981 to 2010 average (NSIDC, 2014c). The seven lowest September extents have all occurred in the past eight years with freeze occurring 10-11 days later per decade in the Chukchi Sea (Stroeve et al., 2014). Within the sub-regions of the Arctic, the Chukchi Sea shows some of the largest reductions (20-30%) in sea-ice extent during the Arctic summer months (Comiso, 2012; Meier et al., 2011, Table 9.2).

Global climate models – scientific tools used to provide climate projections based on the laws of physics – have provided updated sea-ice extent predictions. Some models estimate that the Arctic will be ice free during summer in the mid to later part of the 21st century (Massonnet et al., 2012; Overland and Wang, 2013; Stroeve et al., 2012). There is considerable uncertainty in these estimates (Overland et al., 2014; Wang and Overland, 2012). Regardless of uncertainty, about 90% of the available climate models predict the Arctic will have nearly ice-free conditions during September before 2100 (IPCC, 2013a, Figure 12.31). However, arctic sea-ice losses appear to be occurring at a rate faster than forecast by the global climate models (Stroeve et al., 2012).

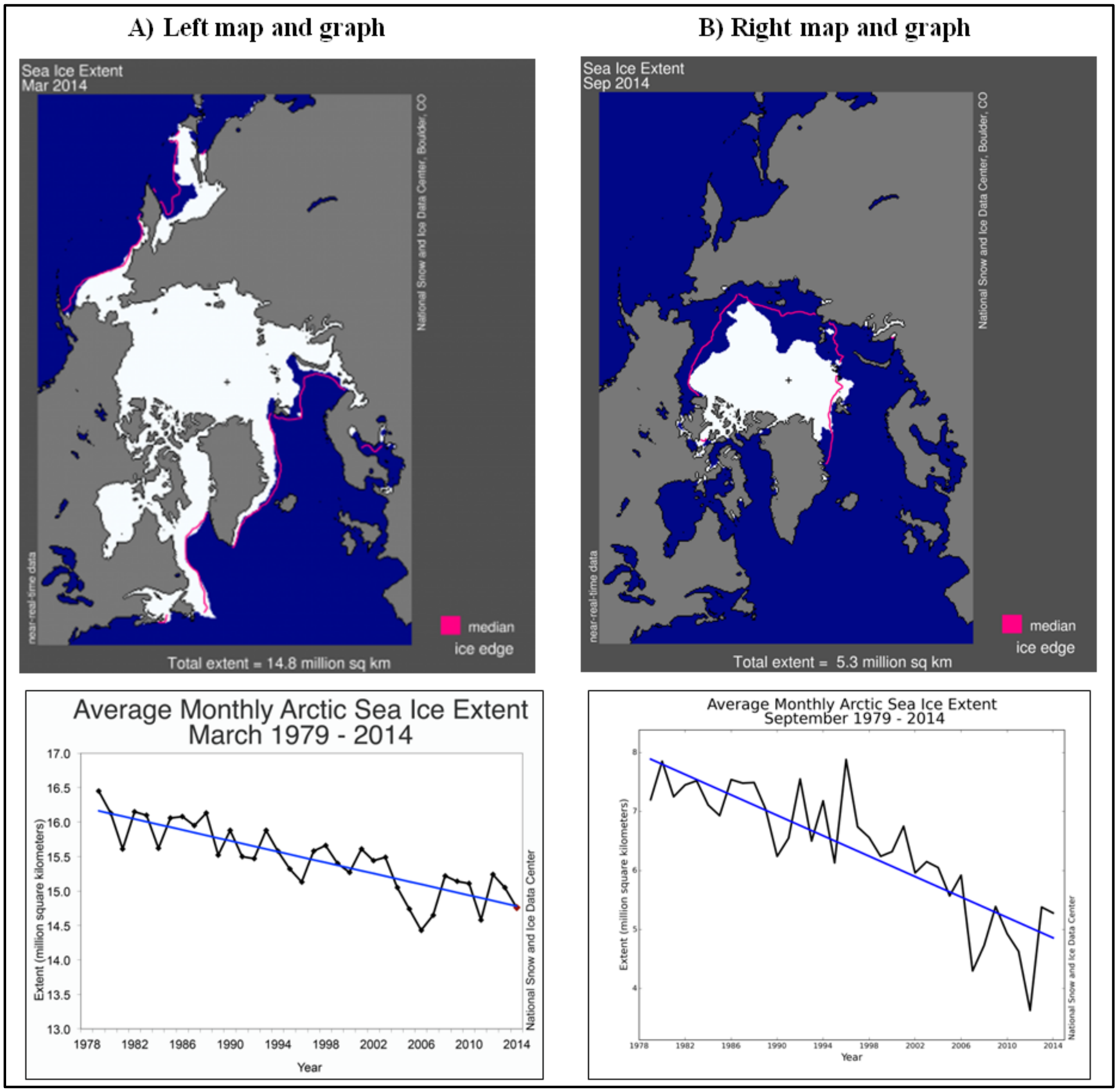

Figure 3-5. Maximum and Minimum Sea-ice Extents for 2014. *A) shows the maximum sea-ice extent (in white) for March 2014, and also the median sea-ice extent (red line) for the period 1980-2010. Graph shows the average monthly sea-ice extent over the period 1979-2014 (NSIDC, 2014a). B) shows the minimum sea-ice extent (in white) for September 2014 and the median sea-ice extent (red line) for the period 1980-2010. Graph shows the average monthly sea-ice extent over the period 1979–2014 (NSIDC, 2014c).*

Ice thickness in the Chukchi Sea region is decreasing and may have decreased from about 2.5 m (8.2 ft) to as low as 1.6 m (5.2 ft) (Richter-Menge and Farrell, 2013). The reduction of the extent and thickness of ice are the drivers of a more mobile sea ice with increased drift speeds (Kwok, Spreen and Pang, 2013; Spreen, Kwok, and Menemenlis, 2011).

The Chukchi Sea summer sea ice has become less extensive amidst a fundamental transition from once widely prevalent and thick multi-year ice to a thinner and readily melted first-year ice cover. The Leased Area is in the portion of the Chukchi Sea that lost multi-year ice from 2007-2008. The sea ice is now a complex mixture of about 75% first year ice and 25% multiyear ice (Richter-Menge and

Farrell, 2013). The sea ice is becoming increasingly seasonal and now consists of mainly first and second year ice on the Chukchi Sea shelf regions (Mudge et al., 2013). The interannual variability in the spatial distribution of first-year and multi-year ice types can change significantly. The prevailing wind direction relative to the Chukchi Sea coastline and shoals along with the frequency of storms keep the entire offshore Chukchi Sea pack ice in a state of continuous transition with leads opening and closing (Mahoney et al., 2012). The nearshore Chukchi Sea is still characterized by recurring coastal leads from March through May (Mahoney et al., 2012, Figure 5.2.1).

There is considerable variability in freeze-up and break-up cycles of the pack ice (Eicken et al., 2014; Weinzapfel et al., 2011, Figure 17). Generally, the pack ice retreat starts in the southern Chukchi Sea and advances northward. By early to mid-June, open water exists from Bering Strait to Wainwright. Nearshore, freeze-up occurs generally during the second week in November and offshore, north of Cape Lisburne, as late as the first week in December (Leidersdorf, Scott, and Vaudrey, 2012). Figure 3-6 shows the weekly maximum percentage of ice incursion into the Leased Areas divided into three areas, Northwestern (NW), Northeastern (NE) and Southern (S) for the period 2006-2013 from May to December (based on weekly archived National Ice Center data). There is a progressively shorter open water season from south to north and west to east. Recent years generally have less summer sea ice than 2006 and prior.

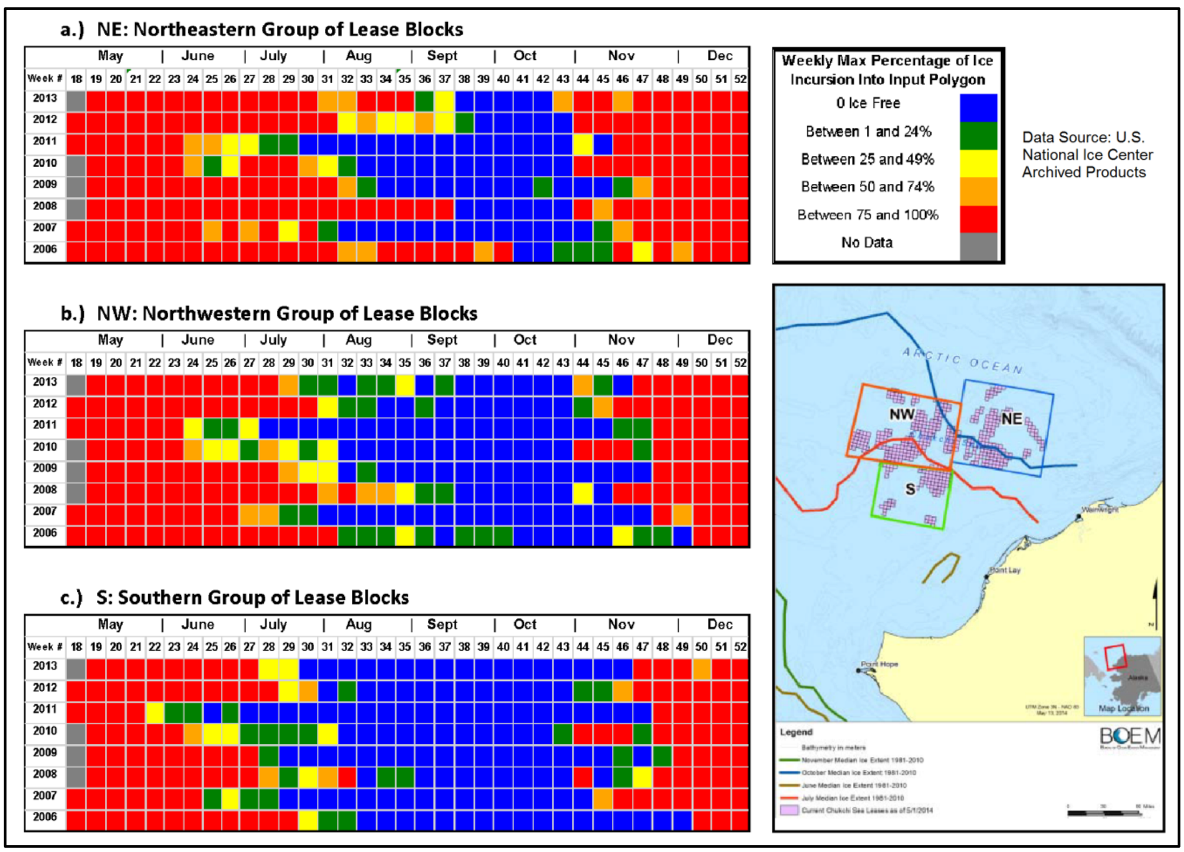

Figure 3-6. Weekly Ice Incursion into Three Groups of Lease Blocks. *Weekly maximum percentage incursion of sea ice into three groups of lease blocks. a.) Northeast, b.) Northwest and c.) South Polygons in the existing leased areas from May through December 2006-2013.*

Nearshore, adjacent to the Leased Area, the landfast ice is also changing. Forty years ago, in late winter, the Chukchi Sea landfast ice edge was 13 km (8 mi) farther offshore, on average, than today (Mahoney et al., 2014). The landfast ice season ends about two weeks earlier for some areas of the Chukchi Sea (Mahoney et al., 2012, 2014). The earliest opening is June 12th with the latest about the first week of July (Johnson et al., 2014). The lagoon freezes around October 15th near Wainwright and around October 4-10 near Point Lay (Johnson et al., 2014).

Declines in sea ice may be attributed to many variables, including a rise in air temperatures, changes in northward heat transport through the Bering Strait, increases in greenhouse gases, and changes in atmospheric circulation and warming ocean temperatures, more first year ice, and the growing importance of ice albedo (discussed in Section 3.1.9) (AMAP, 2011a; IPCC, 2013a; Stroeve et al., 2014; NSIDC, 2014b). The reasons for the changes have been under investigation in the scientific community in observational and modeling studies (Notz and Marotzke, 2012; Wang, Overland, and Stabeno, 2012; Zhang et al., 2013).

3.1.5. Aquatic Invasive Species

An invasive species is defined as "a species whose introduction does or is likely to cause economic or environmental harm or harm to human health where it is introduced" (Executive Order 13112, February 3, 1999). No known marine or freshwater invasive species occur in the U.S. Chukchi Sea and contiguous freshwaters.

Currently, potential vectors for introducing aquatic invasive species include vessel dockage to land, fouled ship hulls, ballast-water discharge, oil rigs, and equipment placed overboard (e.g., anchors, seismic airguns, hydrophone arrays, ocean-bottom-survey cables).

The Arctic Fishery Management Plan (NPFMC, 2009) discusses the potential introduction of invasive species into Alaska arctic waters and the potential effects. The Plan quotes Fay (2002):

> Relatively few non-native, aquatic invasive species have been documented in Alaska. It is believed that this is due to a combination of factors, including geographic isolation; harsh climate conditions and cold temperatures; fewer concentrated, highly disturbed habitat areas; and the state's stringent plant and animal transportation laws. Alaska waters are, however, vulnerable to exotic species invasion. Potential introduction pathways include… the movement of large ships and ballast water from the United States West Coast and Asia.

Climate change can influence the dispersal of invasive species across all vectors and pathways, presenting the potential for increased risk of invasion of non-native species (EPA, 2008; Rahel and Olden, 2008; Hellman et al., 2008; Ware et al., 2014). Climate change influences ice cover, ocean temperature, ocean salinity, ocean acidity, and river discharge, which in turn may act synergistically to increase the risk of introducing invasive species to new areas.

3.1.6. Water Quality

Water quality describes the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose such as protection of fish, shellfish, and wildlife. Important water quality properties include temperature, salinity, density, dissolved oxygen, nutrients, organic carbon, chlorophyll, total suspended sediment, light transmissivity, trace metal concentrations, and hydrocarbon concentrations. Because the water column interacts continuously with seafloor surface sediments (e.g., deposition and suspension of particulate matter), these two aspects of overall water quality are tightly linked. All these water and sediment properties, in turn, are important in determining the distribution, movement and feeding grounds of marine biota.

Chukchi Sea regional water quality is determined by several complex factors interacting including:

- Oceanographic characteristics of inflowing currents
- Formation and melting of sea ice; wind speed and direction
- Water column stratification; seasonal biological activity (e.g., spring plankton blooms)
- Naturally occurring oil/hydrocarbon seeps

- Erosion of organic material along the shorelines

The main rivers that flow into the U.S. Chukchi Sea environment remain relatively unpolluted as human population in the watersheds is sparse.

Currently, the water quality of the Chukchi Sea meets the qualitative criteria for protection of marine life described in Section 403 of the Clean Water Act. As of the most recent listing by the State of Alaska Department of Environmental Conservation (ADEC, 2014), no waterbodies are identified as impaired, as defined by the Section 303d of the Clean Water Act, within the Arctic Region.

Anthropogenic pollution in the Chukchi Sea is primarily related to:

- Aerosol transport and deposition of pollutants; pollutant transport into the region by sea ice, biota and currents
- Discharges from international ship traffic (and consequent potential for marine invasive species)
- Effects from increasing carbon dioxide in the atmosphere (AMAP, 1997, 2004, 2011, 2014; Chernyak, 1996)

Regional industrial activities that influence water quality include five OCS exploration wells that were drilled in the Chukchi Sea between 1989 and 1991, and the Red Dog mine and port that have been operating in the region since 1989.

Several recent studies have contributed to the knowledge of water characteristics and seafloor sediment characteristics in the Chukchi Sea subsequent to the publication of the 2007 FEIS. These recent studies are summarized below.

Water Characteristics: Weingartner and Danielson (2010) examined the variations in winds, sea ice and water property distributions from July to October in 2008 and 2009 in the northeastern Chukchi Sea. They found surface salinity ranges of 28.5 to 31.5 practical salinity units (psu) and surface temperature ranges of –1.0 to +5.0 degrees Celsius (°C) (30.2 to 41 degrees Fahrenheit (°F)) within 10 meters (33 ft) depth. Seasonal changes in water masses were documented over the two seasons of research cruises (Table 3-5). They found that cold, salty winter water is replaced with warmer, fresher summer water and that surface water temperatures are warmer and fresher throughout the season when compared to bottom waters.

Table 3-5. Surface Salinity and Temperature Northeast Chukchi Sea, Open–Water 2008–2009.

2008 Date	Temperature (˚C) at Surface	Salinity (psu) at Surface
August 3– August 12	–1.0 to 1.5	30.5 to 32
August 18– September 20	1.0 to 3.5	28.5 to 31.5
September 9– October 9	0 to 5.0	29.5 to 30.5
2009 Date	**Temperature (˚C)**	**Salinity (psu)**
August 14– August 29	0 to 7.5	29 to 30.5
September 5– September 19	4.5 to 5.0	30 to 31.5
September 26– October 10	2.0 to 4.0	30 to 31

Note: Range of Surface Salinity and Surface Temperature Within 10 Meters in the Central Region of the Northeast Chukchi Sea, Open – Water 2008 and 2009.
Source: Weingartner and Danielson, 2010.

Hydrographic Characteristics: Hydrographic characteristics of the northeast Chukchi Sea were studied by Weingartner et al. (2013a,b) during open water in 2008, 2009, and 2010. The study documented extensive spatial and temporal (seasonal and interannual) variability in water temperature and salinity measurements down to the depth of 40-45 m (131-148 ft). In 2010 alone, the bottom temperatures measured in the study area ranged from -1.57°C to +6.12°C (29°F to 43°F). The authors conclude that the currents flowing north from the Bering Sea in summer and fall, and the bathymetry of the Chukchi Sea shelf, largely determine the complex characteristics of water masses in the northeast Chukchi Sea.

Chlorophyll in the Water Column and Sediments: Grebmeier and Cooper (2012) studied chlorophyll concentrations, which are an indicator of primary productivity of an area, in the northeastern Chukchi Sea. They measured chlorophyll– a concentrations in the water column post–algae bloom, and found that most of the chlorophyll– a settled to sub– surfacewater and seafloor sediments.

Chlorophyll– a in the water column varied from low concentrations (<1 micrograms per liter (µg/L)) in the surface water to higher concentrations in the mid– column and in bottom waters (1– 3 µg/L). In 2010, chlorophyll– a at some mid– column and bottom water stations showed even higher levels, up to 15– 20 µg/L. Higher chlorophyll– a values were found in seafloor sediments in the offshore waters of the northern Chukchi Sea (seafloor beneath the Anadyr current water) compared to lower values in nearshore coastal water (influenced by Alaska Coastal current water).

Total Organic Carbon: Total organic carbon (TOC) and carbon– nitrogen ratios (C/N) in the surface sediments (upper 1 cm) were also determined by Grebmeier and Cooper (2012). The highest TOC concentrations were measured in offshore sediments in the northern and northeast Chukchi Sea, near Barrow Canyon. They suggest that these higher TOC measurements in the northern Chukchi Sea may be related to the greater occurrence of ice and ice–associated algae in the northern compared to the southern Chukchi Sea. The higher C/N ratios in the surface sediments of the southern Chukchi Sea were the result of higher nitrogen concentrations, likely of terrigenous origin.

Total Organic Carbon and Chlorophyll: Blanchard et al. (2013a and b) measured chlorophyll-*a* and TOC in seafloor sediments at five sites in the northeastern Chukchi Sea during three open water seasons (2008-2010). Chlorophyll-*a* measured in the top 1 cm of seafloor sediment over these five sites averaged from 0.015 micrograms per cubic centimeter ($\mu g/cm^3$) at one site in 2009 to as high as 2.554 $\mu g/cm^3$ at a different site in 2010. The average value for TOC measured at the five sites over three years ranged from 5.9 milligrams per gram (mg/g) to 13.3 mg/g (dry wt), both of which occurred in 2010. The authors suggest that topographic features that influence water movement characteristics in the northeast Chukchi Sea determine the delivery of organic carbon to the area.

Nitrogen Cycling: Souza and others (Souza and Dunton, 2012; Souza et al., 2014; Souza, Gardner, and Dunton, 2014) examined nitrogen cycling and nutrients in the water column and at the sediment-water interface at four stations in the Chukchi Sea in the summers of 2009 and 2010. In the southern Chukchi Sea, where waters were warmer and had lower salinity, the study showed high oxygen fluxes into the seafloor sediments, resulting in oxidation of porewater ammonium (NH_{4+}) and outflux of both nitrate (NO_3) and phosphate (PO_4) into the water column.

In comparison, Souza and others found that the northern Chukchi Sea sites were cooler and relatively saline; these sites demonstrated low oxygen fluxes into the sediments and relatively low outflux of nitrogen and nitrate into the water column. Results showed that the nitrification process (ammonium to nitrite to nitrate) explains most of the uptake of ammonium that is in the water column. The study also confirmed previous studies showing that seafloor sediment moving upwards (vertical advection) into the water column transports regenerated nitrogen throughout the water column.

Trace Metals in Sediments: Trefry and others (Trefry, Trocine, and Cooper, 2012; Trefry et al., 2014) studied the distribution of 17 trace metals in sediments of the northeastern Chukchi Sea during open water season in 2009 and 2010. They found that metal concentrations varied with sediment grain size. Once the metal concentrations were normalized to aluminum concentrations present, all but a few sediment samples were above natural background levels. The exceptions to natural background levels were found at two oil and gas exploration sites drilled in 1989. Barium concentrations at 15 of the sample stations were up to 10,000 micrograms per gram (µg/g) within 200 m (656 ft) of the 1989 drill hole, whereas natural background levels of barium range around 700 µg/g. These results indicate that barium from drilling muds settled at drilling sites and at least a portion of the barium did not disperse, but remained at those sites 20 years later.

Anomalies were also detected for copper, mercury, lead, and zinc at 4 stations within 200 m (656 ft) of 1989 drilling sites. The mercury, they concluded, was part of the cuttings brought up during drilling from the geologic formation and residual mercury that occurred in drilling muds. Given that seafloor sediments repeatedly re-suspend, metal concentrations in the seafloor sediments introduce and elevate total-metal concentrations into the bottom water.

Hydrocarbons in Sediments: Neff et al. (2010) examined the chemical characterization of seafloor sediments in 2008 in the northeastern Chukchi Sea in the region of the Burger and Klondike oil and gas prospects. Their results showed that the concentration and distribution of hydrocarbons varied in surface sediments throughout the Burger and Klondike prospects, with higher concentrations in some surface and subsurface sediment samples at the exploration wells drilled in 1989 at these prospects. With the exception of hydrocarbon concentrations in sediments at these two historic drill sites, hydrocarbon concentrations at the other sites sampled within the prospects were within the range of background concentrations reported by other studies in Alaskan coastal and shelf sediments.

Neff et al. (2010) also found that there were higher concentrations of some types of hydrocarbons in the sediments at the Klondike drill site compared to the Burger drill site; they suppose the difference was related to the discovery of crude oil at the Klondike drill site (in 1989) versus the discovery of gas and condensate at the Burger drill site. In addition to hydrocarbons, the researchers report elevated concentrations of barium in the upper 6 cm (2.4 in) of sediments at the 1989 drill sites compared to the rest of the sites sampled. Copper, mercury and lead concentrations were also higher than background in a few of the sediment samples at the former drill sites.

Polycyclic Aromatic Hydrocarbons in Sediments: Harvey et al. (2012, 2014) measured polycyclic aromatic hydrocarbons (PAH) and aliphatic hydrocarbons in surface sediments in the northeast Chukchi Sea. At all but one site, they found concentrations in the surface sediments at or below the natural background levels (<1,600 ng/g (parts per billion) dry wt). One sample station measured 2,956 ng/g (parts per billion) dry wt, exceeding the other samples taken in the study by 2– 20 times the concentration. The authors suggest that the elevated sample could be the result of a natural seep in the region or from one of the old drill sites in the study area.

Mercury: Mercury can be toxic to organisms at certain concentrations and in certain chemical forms. Mercury was measured (as total dissolved mercury) in Chukchi Sea water and sediments by Fox et al. (2014). Concentrations in the seawater ranged from 0.16 to 1.40 ng/L. The distribution and concentrations of total dissolved mercury in water showed three patterns in the water column across the study area. The authors contend that these patterns are related to chlorophyll-*a*, given that primary producers uptake mercury. The study showed that total dissolved mercury and chlorophyll-*a* are acting in a dynamic process in the water column. During post-bloom conditions (and massive uptake of total dissolved mercury by primary producers) high chlorophyll-*a* concentrations were found in the water column, but total dissolved mercury was depleted.

The authors also examined mercury in the seafloor sediments. The lowest mercury values were found in coarse-grained sediments and the highest concentrations were found offshore in silt- and clay-rich sediments. These values, once normalized to natural background aluminum concentrations, showed elevated mercury at two sites within 300 m (984 ft) of two exploration wells drilled in 1989. After eliminating the likelihood that the elevated mercury resulted from impurities from barite drilling muds, the authors concluded that the source of mercury was mercury-sulfide present in the formation which was brought to the seafloor surface as cuttings from the well borehole.

Ocean Acidification

Ocean acidification in the marine environment is occurring as carbon dioxide (CO_2) increases in the atmosphere and the ocean absorbs more CO_2 (AMAP, 2013). This increase in CO_2 forces an increase in hydrogen ion concentration and a lowering of pH over time. Decreasing pH changes the equilibrium of the inorganic carbon system in the sea by reducing the concentration of carbonate ions ($CO_3{-}^2$), an essential molecule for many organisms that produce structures of calcium carbonate ($CaCO_3$).

Researchers (AMAP, 2013; Steinacher et al., 2009; IPCC, 2007a; Mathis, Cross and Bates, 2011) find that the greatest degree of ocean acidification worldwide is predicted to occur in the Arctic Ocean (AMAP, 2013). This amplified scenario in the Arctic is due to:

- Warming air temperatures; sea-ice decrease resulting in a greater surface area of the sea exposed to atmospheric CO_2
- Increases in the occurrences of phytoplankton blooms
- Increased freshwater from snowmelt, ice-melt, and rivers discharged to the marine environment
- Decomposition in the sea of land-originated organic matter
- Increase in storm frequency and intensity forcing mixing and upwelling of organic matter

If CO_2 continues to increase in the atmosphere at the current rate, it is predicted that the future rate of pH decrease would be greater than the current rate of pH decrease (Steinacher et al., 2009; IPCC, 2007a).

The Arctic Monitoring and Assessment Programme (AMAP, 2014) describes the result of these interacting forces and processes that affect the degree, spatial pattern, and rate of ocean acidification in the Arctic as follows:

> Sea-ice cover, freshwater inputs, and plant growth and decay can also influence local ocean acidification. The contributions of these processes vary not only from place to place, but also season to season, and year to year. The result is a complex, unevenly distributed, ever-changing mosaic of Arctic acidification states.

Some research has been conducted on ocean acidification specific to the Chukchi Sea and Beaufort Sea. Mathis and Questel (2013) studied the carbonate chemistry in the Leased Area in the northeast Chukchi Sea during August, September, and October in 2010. The study showed that aragonite and calcite (two forms of calcium carbonate) saturation rates generally decreased in 2010 as the summer progressed, and also decreased with depth. They found low saturation rates (~1.1) for aragonite in bottom water in September and further decreasing in October to ~0.7. In parallel, pH values at this time were depressed to as low as 7.75 and partial pressure of CO_2 reached over 700 µatm. Surface waters in September and October followed a similar trend; however, the values were less deviant than those measured in the bottom water. The authors conclude that increasing atmospheric CO_2 is increasingly penetrating the sea surface and water column, causing these aberrant values measured in September and October 2010.

Similarly, Bates, Mathis, and Cooper (2009) documented abnormally low seasonal saturation or undersaturation (<1) of aragonite and calcite in the Chukchi Sea shelf and Beaufort Sea waters during open water seasons 2002 and 2004. The authors relate these results to seasonal phytoplankton and carbonate saturation interactions fueled by increasing CO_2 in the atmosphere.

Yamamoto-Kawai et al. (2009) collected carbonate chemistry measurements in the Canada Basin of the Arctic Ocean. Their results demonstrated that, over 11 years, melting sea ice forced change in pH and the inorganic carbon equilibrium, resulting in decreased saturation of calcium carbonate in the seawater. Ikawa and Oechel (2013) studied the air-sea exchange of CO_2 in Chukchi Sea nearshore waters throughout June – August, 2008. They found that CO_2 concentration in water was at its lowest in early summer before ice sheets melted and during the phytoplankton bloom at the ice edge.

Increasing ocean acidification is predicted to cause changes in ecosystem processes and present additional stressors to organisms in the Arctic (AMAP, 2013; Kroeker et al., 2013; Steinacher et al., 2009; Bednaršek et al., 2014; Fabry et al., 2008, 2009). Decreased thickness of calcium carbonate structures, and in some cases, increased structure thickness has been demonstrated with depressed pH (Reis et al., 2009). Decreased pH can also affect other important physiological functions such as cell function (Portner, 2008; Dupont et al., 2008).

3.1.7. Air Quality

There are unique characteristics of the affected environment on the Alaska North Slope. The North Slope is located entirely north of the Arctic Circle, and is separated from the more southern areas of Alaska by the Brooks Range; permafrost underlies the entire region; winters are long, cold, and dry, and summers are cool (See Section 3.1.2.).

New information since the preparation of the 2007 FEIS or the 2011 SEIS is provided where the information could alter BOEM's conclusions from those reported in the 2007 FEIS or the 2011 SEIS. New information includes:

- U.S. Fish and Wildlife Service designation of parts of the North Slope adjacent to the Chukchi Sea as "Sensitive Class II Areas."
- National Ambient Air Quality Standards (NAAQS) have been updated in the time since the documents were prepared.
- The Clean Air Act (CAA) was amended in December 2011, changing regulatory jurisdiction over air emissions from OCSLA activities from the U.S. Environmental Protection Agency (EPA) to BOEM.

3.1.7.1. Sensitive Class II Areas

The Alaska North Slope is a vast expanse of flat, treeless tundra. It includes the Arctic National Wildlife Refuge (ANWR) adjacent to the Beaufort Sea OCS, and a small area on the western coast of the North Slope known as the Chamisso Wilderness. The Chamisso Wilderness is a unit of the Alaska Maritime National Wildlife Refuge (AMNWR), and includes Cape Thompson, a headland on the Chukchi Sea, and Cape Lisburne, approximately 50 mi (80 km) north of Cape Thompson. On February 6, 2014, USFWS designated all units of their National Wildlife Refuge System within the Alaska Region as "Sensitive Class II Areas" (USFWS, 2014a). Such areas are afforded special protection from air quality impacts. The remaining areas of the North Slope are also Class II areas, but not "sensitive" Class II areas.

All Class II areas have air quality that does not exceed the Federal air standards defining healthful air, as measured against the NAAQS (40 CFR Part 50). The EPA, using data from monitors on the North Slope maintained by industry for air permit verification, developed a set of background concentrations for the criteria pollutants (EPA, 2014c). A summary of the NAAQS and the background concentrations are provided in Table 3-6.

Table 3-6. National Ambient Air Quality Standards.

Pollutant	Averaging Period	NAAQS Standards		2010 North Slope Background Concentrations (µg/m^3)
		Primary (µg/m^3)	Secondary (µg/m^3)	
Carbon Monoxide (CO)	8-hour	10,000	None	945
	1-hour	40,000		959
Lead (Pb) 4/	Rolling 3-Month Avg.	*NEW* 0.15	Same as Primary	N/A
Nitrogen Dioxide (NO_2)	Annual	100	Same as Primary	2
	1-hour avg. over 3 years	*NEW* 188[5/]	None	Varies by hour

Pollutant	Averaging Period	NAAQS Standards		2010 North Slope Background Concentrations (μg/m^3)
		Primary (μg/m^3)	Secondary (μg/m^3)	
Particulate Matter (PM10) 1/	24-hour	150	Same as Primary	79
Particulate Matter ($PM_{2.5}$) 6/	Annual	*NEW* 12.0 6/	*NEW* 6/ Same as Primary	2
	24-hour	*NEW* 35 8/	Same as Primary	11
Ozone (O_3) 2/	8-hour	*NEW* 156.95 7/	Same as Primary	N/A
Sulfur Dioxide (SO_2) 3/	1-hour	*NEW* 196 9/	1300 μg/m^3	23

Notes: Particulate matter refers to very small particles of liquids or solids that are suspended in air, and are comprised of dust, acids, exhaust, smoke, metals, and organic chemicals. There is no single value that represents the molecular weight of either PM_{10} or $PM_{2.5}$ particles. As such, there is no value reflecting the concentration of PM in parts per million (ppm).
Revoked NAAQS:
1/ PM_{10} annual standard of 50 μg/m^3 is revoked, 10/17/ 2006.
2/ Ozone 1-hour standard of 0.12 μg/ m^3 is revoked, 4/30/2004.
3/ SO_2 annual and 24-hour primary standards of 0.03 ppm and 0.014 ppm, respectively, are revoked, 6/22/2010.
Revised NAAQS:
4/ Lead, three-month rolling average primary and secondary standards are lowered from 1.5 μg/ m^3 to 0.15.μg/ m^3, 11/12/2008.
6/ $PM_{2.5}$ annual primary standard lowered from 15.0 μg/ m^3 to12.0 μg/ m^3, 1/15/2013.
7/ $PM_{2.5}$ 24-hour standard is revised to 35 μg/ m^3, 10/17/2006.
8/ Ozone 8-hour standard is revised to 0.075 ppm (156.95 μg/ m^3), 3/27/2008.
New NAAQS Established:
5/ NO_2 new 1-hr primary standard is established at 188 .μg/ m^3, 2/9/2010.
9/ SO_2 new 1-hour primary standard at 75 parts per billion, 6/22/2010.
Sources:40 CFR Part 50. 69 *FR* 23951, April 30, 2004; 71 *FR* 61144, October 17, 2006; 73 *FR* 16436, March 27, 2008; 73 *FR* 66964, November 12, 2008; 75 *FR* 6473, February 9, 2010; 75 *FR* 35520, June 22, 2010; 78 *FR* 3086, January 15, 2013; and EPA,. 2011b, Table 4.

Emissions of the criteria pollutant, lead (Pb), will not be considered in this analysis as diesel exhaust and volatile organic compounds (VOCs) contain only trace amounts of lead, if any at all. Additionally, for purposes of this analysis, emissions of nitrogen oxides (NO_x) are presumed to include all oxides of nitrogen, including NO_2. Similarly, projected emissions of sulfur oxide (SO_x) are presumed to include all oxides of sulfur, including SO_2. A thorough description of the criteria and precursor pollutants, and the health effects of each, are found in the 2007 FEIS (Section IV.C.1.b). Changes to NAAQS are addressed below.

3.1.7.2. Revisions to the National Ambient Air Quality Standards

The pollutants relevant to this Second SEIS are the NAAQS, the chemical compounds the EPA finds to occur most commonly in the ambient air and which have the potential to cause harm to human health and the environment. The EPA establishes and maintains numerical standards, or “criteria,” for these pollutants, where the criteria are distinguishable between primary and secondary standards. Primary standards are intended to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly. Secondary standards are intended to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings. As a result, the NAAQS are limited by specific criteria, and are referred to as the “criteria pollutants.”

In addition, emissions of VOCs are considered in this analysis. These non-methane reactive organic chemical compounds are emitted directly through stack exhaust, sometimes through evaporation, and participate in the photochemical transformation into ozone, a criteria pollutant. Ozone is not emitted directly from any source; rather, it is a phenomenon that occurs on a regional scale, indeed a global scale, occurring at a time and location far removed from the action that initiated the emissions. Ozone is formed when VOCs and NO_x are transported into the presence of sunshine, so that the pollutants are referred to as ozone precursor pollutants.

3.1.7.3. Change in Jurisdiction for Air Pollution Prevention and Control

On December 23, 2011, Congress enacted the "Consolidated Appropriations Act, 2012" (Act) (Pub. L. 112-74). The Act revised Section 328(a) and (b) of the 1990 CAA Amendments (1990 CAAA). Specifically, the revision to the 1990 CAAA restored regulatory jurisdiction to the Secretary of the Interior for the OCS planning areas adjacent to the Alaska North Slope Borough, which includes the Beaufort Sea OCS and the Chukchi Sea OCS Planning Areas (Arctic OCS), and a small portion of the Hope Basin OCS Planning Area near Cape Thompson and Cape Lisburne.

As a consequence of the Act, air quality regulation of OCS activities in the Arctic OCS is the responsibility of BOEM, rather than EPA. Lessees that propose oil and gas activities within the boundaries of the Lease Sale 193 Program Area are not required to obtain an EPA air quality permit. Instead, plans proposed by lessees for the Chukchi Sea OCS Planning Area must demonstrate compliance with the BOEM Air Quality Regulatory Program (AQRP).

Emission Sources

Emission sources likely to deteriorate air quality are related to how much industry the area supports. Generally, the North Slope is sparsely populated, with just 0.1 persons per mi^2 ($2.6\ km^2$). Barrow, the largest community on the North Slope, is an exception with a population of 4,212. Emissions in Barrow are largely from maintaining infrastructure and supporting the population, such as providing heat and transportation. Emissions from these sources depend on the type of fuel used for heat, and to power various types of vehicles, but are likely to be comprised mostly of nitrogen oxides, sulfur dioxide, and carbon monoxide. Wainwright, Alaska, located 70 miles (113 km) southwest of Barrow, is the third largest community on the western North Slope. The population is less than 1,000. Point Lay, with a population of less than 500, is located 80 miles (128 km) southwest of Wainwright. While some areas of the North Slope occasionally have higher populations due to oil and gas crews, monitors have not provided data that would support any finding other than emission sources are scarce on the North Slope and do not cause problematic pollutant concentrations.

In Barrow, the State of Alaska operates the public Wiley Post-Will Rogers Memorial Airport (BRW), which serves most of the communities of the borough, conducting 12,010 aircraft operations in 2010. The NSB owns and manages the Wainwright Airport (AWI) which conducted 4,129 aircraft operations in 2010. Most of the aircraft operating at BRW and AWI are small single- and twin-engine piston engine aircraft powered by low-lead Aviation Gasoline (AvGas). Such aircraft produce levels of carbon monoxide higher than passenger jets, which operate at BRW but not at AWI. The few passenger jet operations at BRW produce higher levels of nitrogen oxides.

3.1.8. 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. Roth and Ross (2012) found that during the period from 2006-2009, ambient noise measured north of Barrow, Alaska, during periods of open water the highest noise levels were 80-83 dB re: 1μPA2/Hz at 20-50 Hertz (Hz), whereas during months with ice cover has lower spectral levels (70 dB at 50 Hz). Months were both ice cover and low wind speeds had the lowest noise levels (65 dB at 50 Hz).

In the Chukchi Sea, natural underwater noise is strongly influenced by sea ice; however, sea ice also can limit sound propagation because noise scatters "along the rough underside of ice boundaries at high rates than for scattering from the surface of the open sea." This is true for "natural and anthropogenic" sources of noise (Roth and Ross, 2012). Lesser natural influences are from wind-driven ocean waves with ice floes, temperature changes that cause tensile cracks, snow cover, and ice fog. Animal vocalization sand sounds are caused by whale calls, echolocation clicks, and snapping shrimp.

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 offshore industrial activities (Greene and Moore, 1995; Greene, 1995).

Arctic underwater noise, both natural and anthropogenic, is impulsive, and its temporal distribution can be highly non-Gaussian (i.e. not a normal distribution) due to sea ice dynamics.

3.1.9. Climate Change

The Earth's climate is naturally variable. After exiting an ice-age some 20,000 years ago, the Earth is now in a warming trend. Fluctuations in the global climate are the natural consequence of the Earth's energy budget (radiation balance), which is the system of heat transfer between the Earth and the Sun; a natural process that seeks equilibrium. When the system's natural radiation balance is upset by excess GHGs in the atmosphere, net warming occurs. Evidence from ice-core data from Antarctica shows the sinuous historical record of temperature versus the concentration of GHGs over a period of 420,000 years before present (B.P.) (Petit, Jouzel, and Raynaud et al. 1999). The fluctuations in the climate are depicted in Figure 3-7.

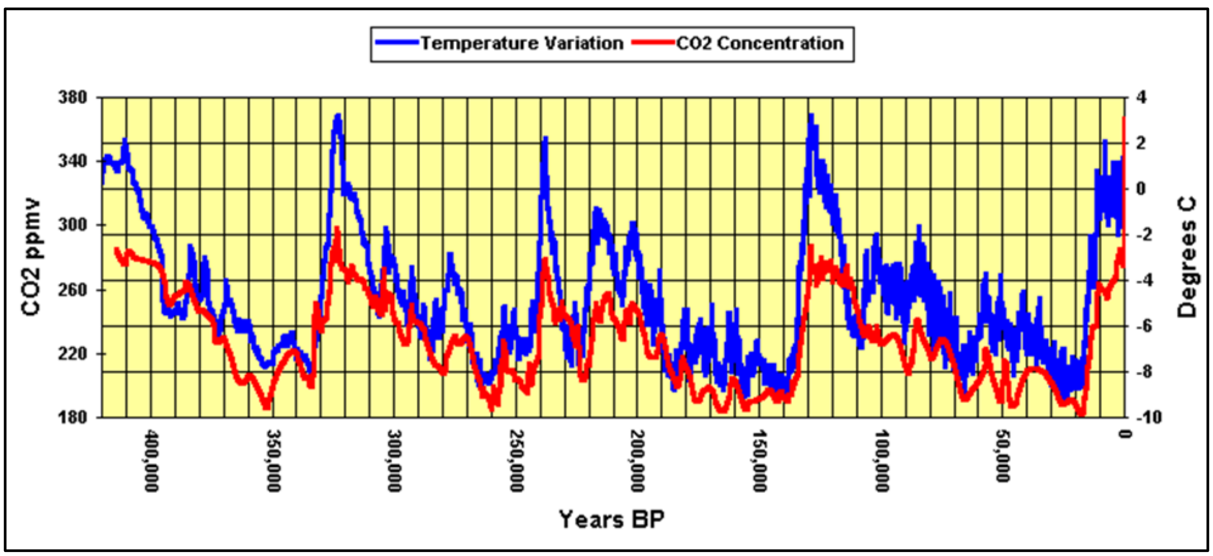

Figure 3-7. Chronological Temperature and CO_2 Concentrations. *This image reflects results from ice-core data collected from the Vostok site in Antarctica and published in the British journal, Nature. The graph shows the correlation between CO_2 concentration levels, over time, and temperature changes through four glacial cycles dating back 420,000 years. The graph measures the concentration of CO_2, in units of parts per million by volume (ppmv) against temperature in degrees Celsius, against the years "before present" (B.P.) in demarcations of 10,000 years. The thicker lines of temperature beginning approximately 100,000 B.P. is the result of more copious data than was available for the previous periods. Source: Petit et al. (1999).*

As with many fields of science, uncertainties exist in the field of climate change. Outstanding questions remain such as how much and at what rate warming will occur, and how such effects will globally influence precipitation, storms, and wildlife habitat, etc. The science used to predict the consequences of global emissions is continually evolving. The International Panel on Climate Change (IPCC) released its Fifth Assessment Report (AR5) in 2013 providing updates, including updates with respect to climate changes in the Arctic (IPCC, 2013a and 2013b). While the science is evolving, scientists generally agree the warming trend is accelerating at an unusually rapid rate and is caused by increased emissions of GHG produced by human activities. For example, the United Nations Framework Convention on Climate Change (UNFCCC) suggests that climate change is attributable to human activities that have altered atmospheric composition and caused climate variability beyond what can be explained by natural causes (IPCC, 2014).

The IPCC estimates global net warming will occur in the future as the mean surface temperature increases up to 3.7 °F/1.48 °C by the year 2100. While there may be periods during that time when the global temperature will cool or remain steady, it is believed the average trend will be a net increase in temperature.

Greenhouse Gases (GHG).

GHGs are chemical compounds that contribute to the greenhouse effect by absorbing infrared radiation from the sun. When an overabundance of GHGs is present in the lower atmosphere, too much heat can be trapped, and the net temperature of the earth increases. Some GHGs, such as CO_2, occur naturally and are emitted to the atmosphere through natural processes and human activities. Other GHGs are created and emitted solely through human activities. The three most abundant GHGs caused by human activities are:

Carbon dioxide (CO_2). CO_2 enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions. CO_2 is also removed from the atmosphere when it is absorbed by plants as part of the biological carbon cycles (EPA, 2011d). Concentrations of CO_2 have increased steadily since the beginning of the industrial era from an annual average of 280,000 parts per billion (by volume) (ppbv) in the late 1700s to 396,000 ppbv, or 0.0396%, at Mauna Loa in 2013 (EPA, 2014d). CO_2 is not destroyed in the atmosphere over time; some molecules may remain in the atmosphere for 50 to 500 years. The graphs in Figure 3-8 depict the recent increases in CO_2 emissions.

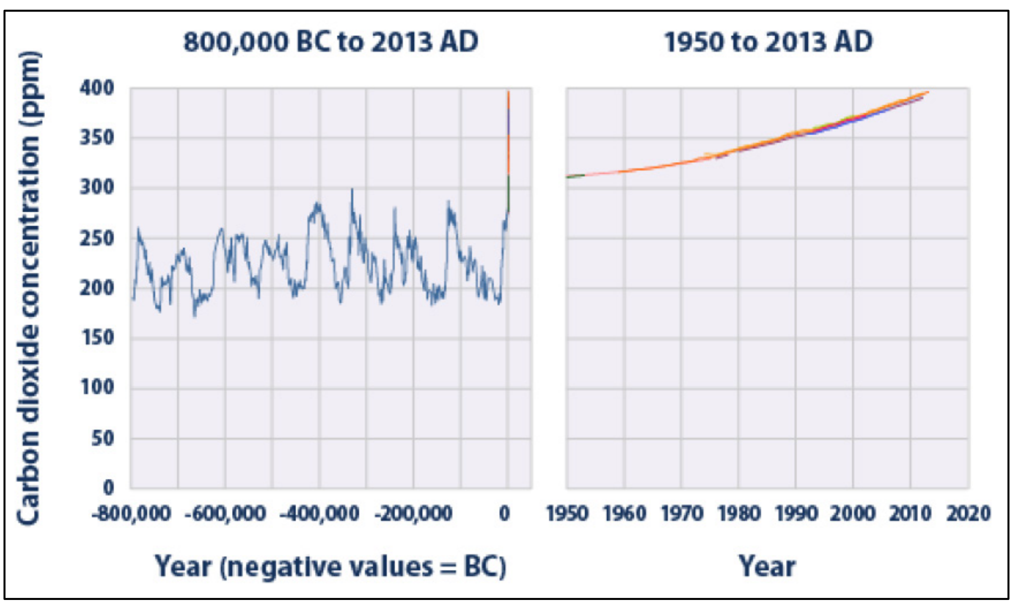

Figure 3-8. Global Atmospheric Concentrations of Carbon Dioxide over Time. *These graphs show the concentrations of CO_2 in the earth's atmosphere dating back hundreds of thousands of years through 2013, measured in parts per million (ppm). The graph on the right shows the increase of CO_2 emissions in the past 63 years until 2013. Source: EPA (2014d).*

Methane (CH_4). CH_4 is emitted during the production and transport of coal, natural gas, and oil. CH_4 emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills (EPA, 2011c). Concentrations of CH_4 have more than doubled since preindustrial times, and was 1,800 ppbv, or 0.00018%, in 2013 – due primarily to use of fossil fuels (EPA, 2014d). Methane remains in the atmosphere for 12 years. Pound for pound, the warming impact from emissions of CH_4 is over 20 times greater than CO_2 (EPA, 2014a).

Nitrous oxide (N_2O). N_2O is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste (EPA, 2011d). After rarely exceeding 280 ppbv over the last 800,000 years, levels of N_2O have increased since the 1920s to a new high of 326 ppbv, or 3.2E-5% – due primarily to agriculture (EPA, 2014d). Nitrous oxide molecules remain in the atmosphere for an average of 120 years, until transformed through chemical reactions. The impact of one pound of N_2O is over 300 times that of one pound of CO_2 with respect to the ability to absorb heat (EPA, 2014a).

3.1.9.1. Systems Driving Global Climate Change

There are many factors that influence global climate. The earth has many climates, ranging from the tropical (warm and moist) to the polar (cold and dry). Climate zones are controlled by various topographical, oceanographic, and meteorological features (Ahrens, 2013). These features include intensity of sunshine (which can vary by latitude), distribution of land and water, ocean currents, prevailing winds, high-and low-pressure areas, mountain barriers, and altitude. The systems that influence the global climate still naturally fluctuate. These fluctuations, or oscillations, can have an impact on the climate, both locally and on the global scale.

The Pacific Decadal Oscillation (PDO), the North Atlantic Oscillation (NAO), and the Arctic Oscillation (AO) are all patterns of climate variability that are believed to influence global and Arctic climate. The PDO describes the fluctuation in northern Pacific sea surface temperatures that alternate between above normal (negative phase) and below normal (positive phase) Pacific Ocean sea surface temperatures. These cycles operate on a 20- to 30-year time scale (NOAA, 2011), and were believed to be associated with shifts in the climate of the North Pacific around 1948 and 1976 (Bond, 2011). The last major shift in the PDO occurred in 1976-1977, marking a change from cold to warm conditions in Alaskan waters (Bond, 2011, as reported in NMFS, 2013a).

The NAO is a climate system that is the dominant mode of winter climate variability for a geographic area extending from the North Atlantic region, to central North America, Europe, and Northern Asia. The NAO is a large-scale atmospheric mass that controls the strength and direction of the westerly winds and storm tracks across the North Atlantic. A positive NAO index is associated with stronger and more frequent winter storms crossing the Atlantic Ocean. The NAO has trended toward the positive phase over the past 30 years (Bell, 2011, as reported in NMFS, 2013a), which is associated with stronger and more frequent winter storms crossing the Atlantic Ocean (Dickson et al., 2000, as reported in NMFS, 2013a).

The AO is a climate cycle system that influences climate patterns in the Arctic. The AO is very similar to the NAO with respect to timing and effects on local temperatures and precipitation (NMFS, 2013a). The AO is defined by the location of synoptic surface pressure patterns (highs and lows) at the polar and middle latitudes that, on occasion, nearly reverse position, and "oscillate" between positive and negative phases from one winter to the next. A visualization of the AO, both the negative and positive phases for the winters of 2010 and 2011, is provided in Figure 3-9 (Douglas, 2012).

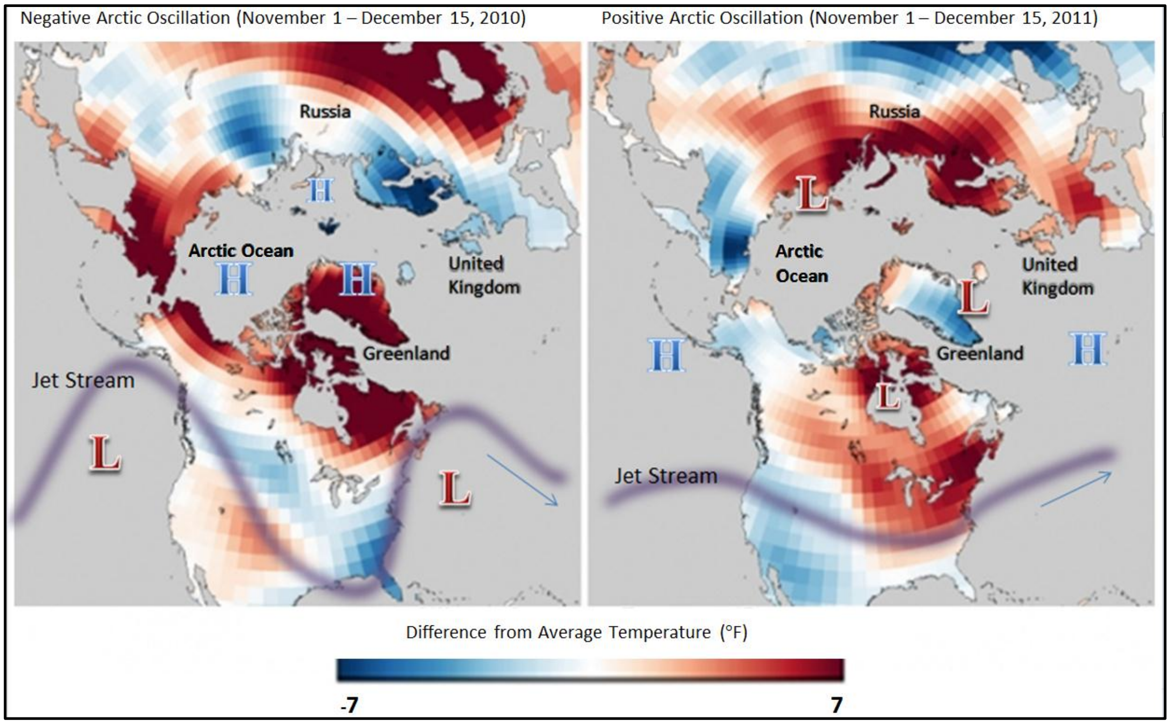

Figure 3-9. Arctic Oscillation phases. *This diagram visualizes the approximate average locations of high and low pressure centers and the jet stream location that define the negative and positive phases of the Arctic Oscillation, superimposed on a world temperature map of 2010 and 2011. The positive phase shows low pressure over the polar region and higher pressure in the Northern Pacific and Northern Atlantic Oceans. This pattern directs ocean storms more to the north, with warmer and wetter weather above the jet stream, including the coastline of the Chukchi Sea in Alaska. The eastern United States has warmer than normal temperatures in the positive phase. When shifting to the negative phase, the winds become weaker, and the jet stream develops a deep trough over the central United States, allowing cold air to drive southward. This causes an increase in storms in the middle latitudes with much warmer temperatures on the Alaska North Slope and colder than normal temperatures from western Canada to Florida (Douglas, 2012). Sources: Adapted by BOEM from Douglas (2012); Watts (2010) and Herring, Higgins, and Halpert (2010).*

Graphs of the historical occurrence of the annual AO index, whether positive or negative, are shown in Figure 3-10. On the graphs, the positive phases of the AO are indicated by marks above the zero-line, and the negative phases, below the line. Since 1950, the AO has fluctuated between the negative and positive phases, being mostly negative through the 1990s, when a more intense positive phase prevailed. During the 2000s, the AO has fluctuated, having a more intense negative phase in 2010, followed by another positive phase. The AO can change from a positive to negative mode, or vice versa, in a matter of weeks. The increase in incidence of the AO negative phase supports continued warming in the Arctic Ocean and Alaska (NASA, 2011).

3.1.9.2. Climate Change in the Arctic

Changing regional climates is nowhere as evident as in the Arctic, where the climate is changing at a faster pace than other regions of the world (NOAA, 2014a). Alaska's climate conditions have ranged from one extreme to another over a period of millions of years. Fossil records from the mid-Cretaceous Period indicate that the Arctic was substantially warmer than present-day conditions, and the geography, atmospheric composition, and ocean currents were considerably different than current conditions (ACIA, 2010, as reported in NMFS, 2013a).

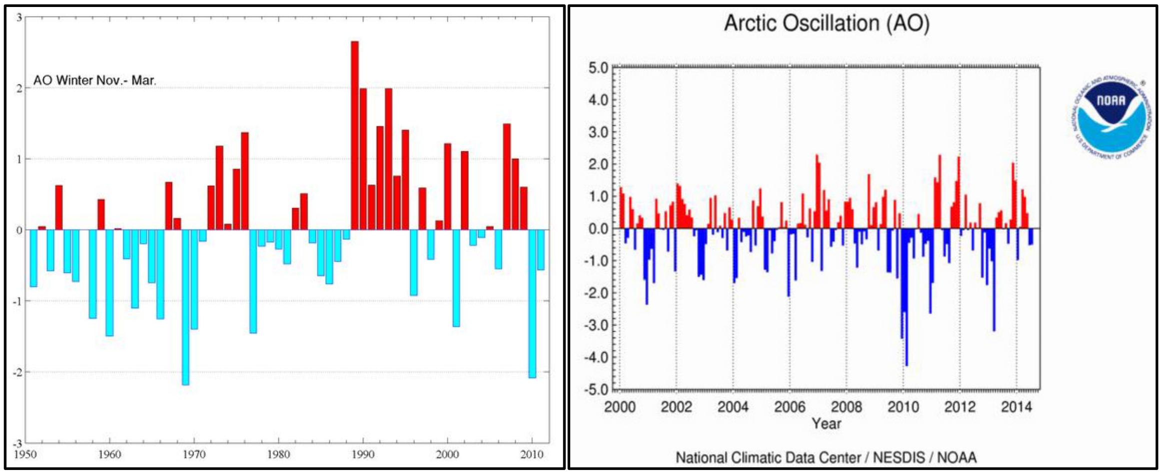

Figure 3-10. Chronological Arctic Oscillation Phases. *The charts show the changes in the AO beginning in 1950 until 2010 (left) and in the decade of the 2000s (right). Source: NOAA, 2014b.*

Geophysical, biological, oceanographic, atmospheric, and anthropogenic sources provide evidence of the climate changing in the Arctic in recent decades. For example, temperature recordings taken by the National Weather Service Office in Barrow from 1961 through 2010 and compiled by the Western Regional Climate Center in Reno, Nevada provide evidence of the warming in the Arctic (WRCC, 2014). The temperature recordings show that Barrow's mean temperature increased from 9.4°F/-12.6°C during the 30 years from 1961-1990, to 11.8°F/-11.2°C during the 30 years from 1981–2010, an increase of 2.4°F/1.4°C.

Evidence of the Arctic climate warming is also supported by traditional knowledge from Alaska Native communities along the Beaufort and Chukchi Seas. Residents of these communities have reported changes in thickness of sea-ice, increased snowfall, drier summers and falls, warmer temperatures, forest decline, reduced river and lake ice, permafrost degradation, increased storms and coastal erosion, and ozone depletion. The changes reported by local residents are generally consistent with the scientific evidence of climate change (NSIDC, 2011, as reported in NMFS, 2013a):

- Air temperatures in the Arctic are increasing at an accelerated rate
- Year-round sea-ice extent and thickness has continually decreased over the past three decades
- Water temperatures in the Arctic Ocean have increased
- Changes in salinity of the Arctic Ocean has occurred
- Rising sea levels
- Retreating glaciers
- Increases in terrestrial precipitation
- Warming permafrost
- Northward migration of the tree line

Although verifying such trends in the Arctic is challenging due to the small number of monitoring stations and relatively short records of data, the following statistics for the Arctic published as part of the Arctic Climate Impact Assessment support these trends (ACIA, 2004 and ACIA, 2005, as reported in NMFS, 2013a):

- A warming trend in the Arctic of 0.160°F/0.089°C per decade compared to 0.110°F/0.061°C, per decade, for the globe
- A warming trend of 0.70°F/0.389°C per decade over last four decades
- Precipitation increase of approximately 1% per decade over the past century

- Snow extent decrease of approximately 10%
- Permafrost warming almost 3.6°F/1.45°C over the past three decades
- A rise in Arctic Sea level of 10 to 20 centimeters (cm) (3.9-7.9 in) in the past century
- An 8% decrease in annual average sea-ice extent over the past three decades
- A 15% to 20% decrease in the extent of summer sea ice over the past three decades
- A mean annual increase in temperatures by 2.4°F/0.78°C over the last five decades (WRCC, 2014)
- A decrease in sea-ice thickness by 42% since the middle 1970s
- An increase in mean winter temperatures by 11.8°F/ 6.02°C over the last five decades (WRCC, 2014)

Changes in the Arctic climate are illustrated in reductions in sea ice over the past several decades. According to the National Aeronautics and Space Administration (NASA), the annual minimum summer extent of Arctic ice coverage in September 2013 was (1.97 million mi^2) (5.10 million km^2). The extent of sea ice varies from year to year, for example, the 2012 annual minimum summer extent was 1.32 million mi^2/3.41 million km^2, about half the size of the average minimum extent from 1981 to 2010. According to NASA:

> "The trend with decreasing sea ice is having a high-pressure area in the center of the Arctic, which compresses the ice pack into a smaller area and also results in clear skies, which enhances melting due to the sun." Further, "The character of the ice is fundamentally different: It's thinner, more broken up, and thus more susceptible to melt completely. This year [2013], the cool temperatures saved more of the ice. However, the fact that as much of the ice melted as it did is an indication of how much the ice cover had changed. If we had this weather with the sea ice of 20 years ago we would have had an above-normal extent this year [2013]" (NASA, 2013).

Because thinner ice melts at an accelerated rate than does thicker ice, the average thickness of Arctic ice is expected to decrease further, particularly the extent of the summer ice. NASA further predicts that at this rate, Arctic summer ice may disappear completely within this century (NASA, 2013).

Continued loss of sea ice could cause further warming through albedo feedback. Albedo feedback occurs when a change in the area of snow-covered land, ice caps, glaciers, or sea ice alters the reflectivity of a surface. Albedo (Î±) is a value that indicates the reflective ability of a surface from 0 to 1. Generally, the whiter the surface, the more reflective it is, and the value tends toward 1; conversely, the darker the surface, the less reflective it is, and the value tends toward zero. Cooling increases ice coverage and increases the albedo. Increased albedo leads to increased cooling as the amount of solar energy absorbed is minimized. Conversely, decreased albedo leads to increased warming as the amount of solar energy absorbed is maximized (Deser, Walsh, and Timlin, 2000). See Table 3-7 for comparisons of the albedo values for three surfaces.

Table 3-7. Ice-Albedo Comparisons.

Surface	Cooling (Î±, percent reflected)	Heating (percent absorbed)
Ice	0.50 or 50%	0.50 or 50%
Snow covering ice	0.90 or 90%	0.10 or 10%
Open Ocean	0.06 or 6%	0.94 or 94%

Source: NSIDC, 2014b.

In the warming Arctic climate, this feedback loop has the potential to increase sea levels; alter the salinity (NASA, 2013); cause an increased release of methane (CH_4) into the atmosphere due to melting of permafrost; and increase storm tracks, patterns of precipitation, and the frequency and severity of cold-air outbreaks in middle latitudes (ACIA, 2005 and NMFS, 2013a).

Soot, or Black Carbon (BC), plays a role in short-term climate effects in the Arctic. The particles that comprise BC are created by the combustion of fossil fuels and by forest fires. BC particles can originate in other countries and be transported to the Arctic area. The dark color of the particles decreases albedo after deposition on the ice and snow causing incoming radiation to be absorbed. Unlike GHGs, the particles of BC are short-lived in the atmosphere with a lifetime of days to weeks. The "cloud" of BC occurs over the Arctic from early winter until springtime. Climate effects from black carbon are especially strong in sensitive areas such as the Arctic, resulting in earlier annual spring melting and sea-ice decline. Because of the visual effect, the impacts are recognized more immediately than impacts from GHGs (USDOI, BLM, 2012).

The oceans are natural reservoirs of inorganic carbon. In addition, about 30% of the total anthropogenic emissions of CO_2 accumulates in the ocean. This accumulation from anthropogenic CO_2 results in the gradual increased acidification of the oceans. Thus, the presence of additional CO_2 decreases the pH levels, which increases potential threats to the health of the world's oceans ecosystems (IPCC, 2013).

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).

Seawater that is supersaturated with calcium carbonate minerals typically supports abundant healthy marine life. Calcium carbonate minerals provide the means for calcifying organisms to build their skeletons and shells. Continued ocean acidification would cause some parts of the ocean to become less saturated with the needed mineral, which is likely to affect the ability of some organisms to produce and maintain their shells, as shown in Figure 3-11. (NOAA, 2014b).

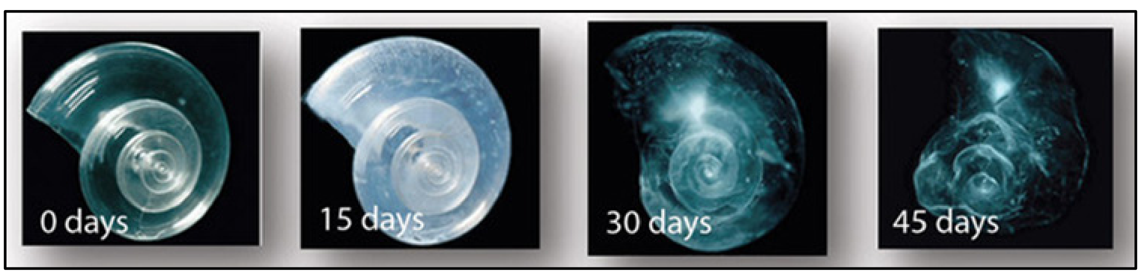

Figure 3-11. Pteropod Shell Deterioration by Acidification. *The pteropod, or "sea butterfly," is a tiny sea creature about the size of a small pea. Pteropods are eaten by organisms ranging in size from tiny krill to whales, and are a major food source for North Pacific juvenile salmon. The photos above show what happens to a pteropod's shell when placed in sea water with pH and carbonate levels projected for the year 2100.The shell slowly dissolves after 45 days. Photo credit: David Liittschwager/National Geographic Stock.Source: NOAA, 2014b.*

Climate change has global implications. The map in Figure 3-12 depicts various types of observed impacts attributable to climate change. The map appears in a document supplementing the latest assessment report published by the IPCC. With respect to the Arctic, the IPCC indicates a high confidence that changes to the following are attributable to climate change: glaciers, snow, ice, and permafrost; coastal erosion and/or sea level effects; terrestrial ecosystems; marine ecosystems; and livelihoods, health and/or economics.

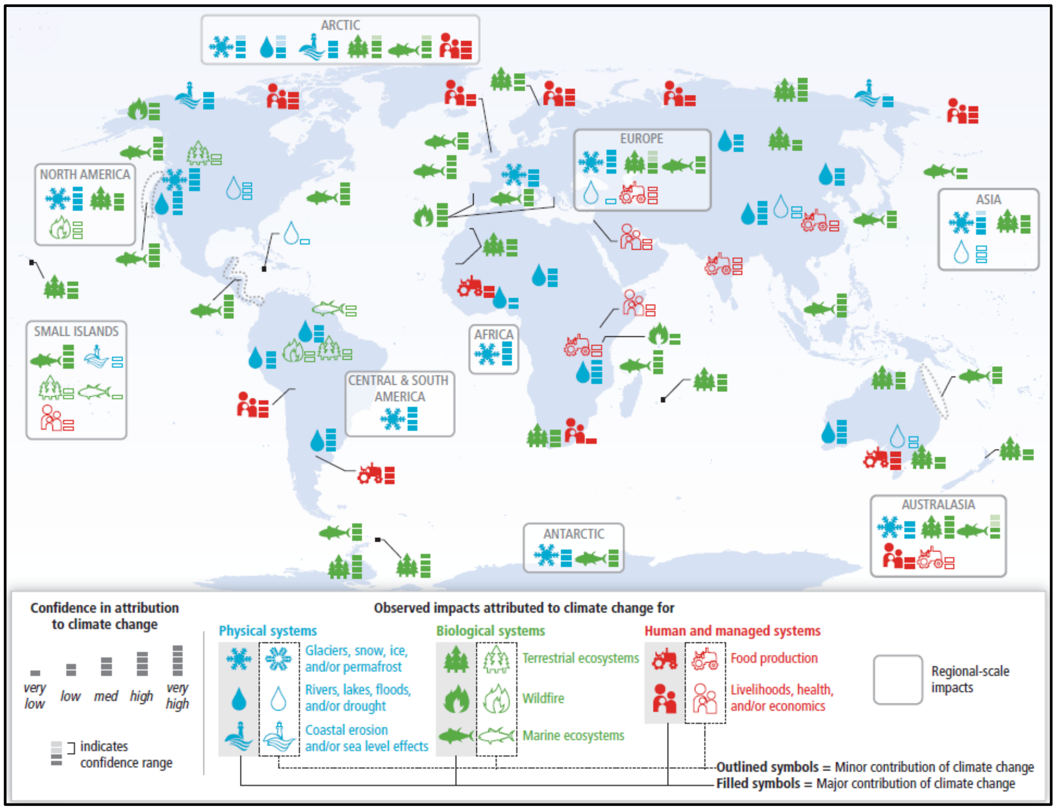

Figure 3-12. Widespread climate impacts in a changing world. *This diagram illustrates the impacts in recent decades attributed to climate change, based on studies reviewed since the IPCC Fourth Assessment Report (AR4). Source: IPCC, 2014, Figure SPM.2 pp.7*.

3.2. Biological Environment

3.2.1. Lower Trophic Level Organisms

The Chukchi Sea is generally thought of as having the highest benthic faunal mass of all the Arctic shelves (Dunton et al., 2005; Sakshaug, 2004). A review paper by Grebmeier et al. (2006), synthesizing 20 years of data from interdisciplinary oceanographic cruises, found there are areas of high benthic biomass and abundance in both the south central and northeast Chukchi Sea. Grebmeier et al. (2006) explain that the large biomass is due to nutrients deposited by plankton blooms living out their life cycles and sinking to the seafloor along the Chukchi Sea Shelf. Organic matter sinking to the benthic surface creates a coupling, or link, between the pelagic and benthic surfaces, providing a source of energy for the diverse and abundant life that lives on and in the seafloor. In the future this may change to a more pelagic based cycle, due to climate forcing of systemic change being caused by changing ice regimes and warming ocean temperatures (Grebmeier, 2012b; McTigue and Dunton, 2014). Blanchard et al. (2013a and b), give an example of the high abundance of animals living on or near the benthic surface in this area. The average number of organisms living in the Leased Area in the northeast Chukchi Sea ranged from ~800 (on the Klondike prospect 2008) to ~4000 individuals per m^2 (on the Burger prospect 2009) during the study period. Kelp and seagrass communities are also present in the Chukchi Sea but are located only inshore of the Leased Area (Phillips et al., 1984). Their spatial extent is probably limited by the lack of cobblestone rock and other hard substrate (Dunton et al., 2000).

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 Second 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 upper sedimentary layers of the benthic surface). The epontic community consists of those lower trophic organisms living on and in the sea ice.

Pelagic Communities

The plankton communities found in the Chukchi Sea are primarily (by numbers of individuals) phytoplankton, with the remainder consisting mostly of small 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 (Questel, Clarke, and Hopcroft, 2013). 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, 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 Sea zooplankton are 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, McTigue and Dunton, 2014). 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 (Bluhm et al., 2009; Ravelo et al., 2014). Nauplii larvae of resident copepods (known as holoplankton, and living their entire developmental cycle within the planktonic masses) are diverse and abundant (Bluhm et al., 2009).

Copepods are well represented in planktonic masses of Arctic waters representing 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 (Questel, Clarke, and Hopcroft, 2013). Within the Chukchi Sea and adjoining basin, there is considerable diversity of both small and large squid, and 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 *Oikopleura vanhoeffeni* have been observed. Pteropods, or pelagic molluscs, are often abundant and represent an important component of biomass in the region (Questel, Clarke, and Hopcroft, 2013).

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 et al., 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., 2005; Quijon, Kelly, and Snelgrove, 2008). Zooplankton grazing on the phytoplankton are lower in abundance during spring blooms, thus increasing the available nutrients for benthic organisms (Questel, Clarke, and Hopcroft, 2013).

Kelp beds (communities dominated by the large kelp *Laminaria solidungula*) occur in at least two areas along the Chukchi Sea coast. One first described by Mohr, Wilimovsky, and Dawson (1957) and confirmed by Phillips et al. (1984) is located about 20 km (12 mi) northeast of Peard Bay near Skull Cliff. Another was reported by Phillips and Reiss (1985) approximately 25 km (16 mi) southwest of Wainwright. The known kelp beds are located within Alaska State waters. These unique biological communities exist on bottom substrates dominated by cobblestone or rock that support highly diverse and abundant epifaunal communities dominated in numbers by amphipods, polychaetes, cumaceans, sponges, corals (including the soft coral *Geremisa rubiformis*), and sponges (Dunton and Schonberg, 2000). The Ledyard Bay Critical Habitat Area is southwest of these communities. The BOEM-funded COMIDA-CAB study (Dunton et al., 2012) included benthic ecology studies with collection and analysis of both epifaunal and infaunal populations. Information regarding epifaunal communities was published by Ravelo et al. (2014). Trawls were conducted at 53 stations between Barrow Canyon and Hanna Shoal, 47 of them within the boundaries of the Klondike and Burger Leased Areas. Stations of high invertebrate abundance tended to be located along the path of the nutrient rich central current from the Bering Strait. Abundance was dominated by brittle stars comprising 71% of invertebrates collected, followed by sea cucumbers (19%), caridean shrimps (3%), and snow crabs (*Chinonectes opilio*, 2%). The remainder of the collections included crustaceans such as amphipods and hermit crabs, mollusks such as bivalves, moon snails and whelks, and cnidarians such as the anthozoan soft coral *Gersemia rubiformis* and sand dollars. Abundance and diversity were higher in the north eastern study area near Hanna Shoal and the mouth of the Barrow Canyon.

Information regarding infaunal communities was published by Schonberg, Clarke, and Dunton (2014) from collections during the BOEM COMIDA-CAB project. A total of 52 sites (47 within the Klondike and Burger prospects) were sampled across the Leased Area west of Barrow Canyon and south of Hanna Shoal. Starting at the southeast corner of Klondike and moving into the northwest corner of Burger, increases were observed in abundance and diversity of benthic communities, percentage of mud in the substrate, and water depth. Schonberg, Clarke, and Dunton found the Leased Areas exhibited differences in substrate composition, water depth, and infaunal community compositions. Representatives from 361 taxonomic categories of infauna were identified. Polychaetes, mollusks, and burrowing or tube-dwelling amphipods dominated these communities. Overall, 38% were polychaete worms, 22% were mollusks (bivalves and snails), and 21% were crustaceans (mostly amphipods and cumaceans). Number of species collected at any one station varied from 13 near Klondike to 102 near the mouth of Barrow Canyon. Species diversity and abundance were highest in the area between Hanna Shoal and the mouth of Barrow Canyon, which includes the Burger area. The diversity and abundance of these communities have also been documented in publications from the Chukchi Sea Environmental Science Program, a multi-year science program focused on the same area and funded by industry, with Blanchard et al., (2013 a and b), and Day et al., (2013). These studies, as well as Dunton, Grebmeier, and Trefry (2014) from the

BOEM COMIDA-CAB project, discussed high primary productivity from plankton blooms providing energy for the formation of abundant and diverse benthic populations. The assemblages of lower trophic communities within the Leased Area tended to follow distinct spatial distribution patterns that matched the path of current flows and seasonal movements of water masses.

Epontic Communities

As sea ice forms and dissipates in the Arctic region, the physics of ice formation and local changes in temperature and salinity create a diversity of ice classifications. Diverse communities of epontic organisms live on and within this ice, inhabiting three-dimensional networks of brine channels and ice crystals, including the exterior surfaces of ice-water interfaces (Horner et al., 1992). Arctic sea ice and its ice associated assemblages of biota are unique, with numerous ice endemic species (those only found in or on ice) as well as generalists taking advantage of the available habitats and abundance of life they support. Many organisms are small, including virus and bacteria that make up the majority of the abundance of epontic organisms that are found in every sample of sea ice (Deming, 2002). Ice algae are also common, with diatoms making up the majority of species found. One study found more than 250 species of diatoms in two ice cores collected in June of 1998 from pack ice in the northern Chukchi Sea (von Quillfeldt, Ambrose, and Clough, 2003). Other algae such as dinoflagellates are also common, with colored bands of algae often seen in ice floes (Arrigo, Mock, and Lizotte, 2003). Lee et al. (2008) found that ice algae contributed 74% of under-ice pelagic productivity during winter months of no photosynthetically active radiation (light levels high enough to allow growth), performing a sustaining capacity in the environment enabling survival of pelagic and benthic communities. This organic matter produced within the sea ice serves as the base for the ice-associated food webs and includes consumers such as protozoans (single celled organisms), and metazoans (larger multi-celled organisms). Protozoans are represented by organisms such as ciliates, rotifers, and amoebas (Caron and Gast, 2009). Removal of upper layers of snow from ice floes often reveals colored patches consisting of dense assemblages of protozoans. Metazoans are represented by many animals such as copepods, copepod nauplii, nematodes, turbellarians, and, in the case of offshore fast ice, larvae of benthic polychaetes and gastropods (Horner et al., 1992). Epontic communities also consist of numerous crustaceans (dominated by amphipods and copepods), larval polychaetes, naupli larvae of crustaceans, and nematodes (Bluhm, Gradinger, and Schnack-Scheil, 2009). Amphipods are normally the most numerous crustaceans, with the underside of ice floes often supporting large communities of gammaridean amphipods that have been found to exist in numbers of more than 1,000/m^2. These amphipods are the dominant macrofaunal taxon in the Arctic under-ice habitat and are thought to be the major consumers of ice algal production in the Arctic (Gradinger and Bluhm, 2005). Larval fish are also common members of epontic assemblages, with Arctic cod often using brine channels as feeding and resting places, or as refuge from predators (Gradinger and Bluhm, 2004).

3.2.2. Fish

Summary of 2007 FEIS and 2011 SEIS

The discussion of fish and fish habitat that follows is in addition to the full description of these species and their habitats in the 2007 FEIS (Section III.B.2) and the 2011 SEIS (Section III.B.2). The U.S. Chukchi Sea and western Beaufort Sea support at least 98 fish species representing 23 families (Mecklenburg, Mecklenburg, and Thorsteinson, 2002; Mecklenburg, Moller and Steinke, 2011; Fautin et al., 2010). Fish are commonly defined by three general groupings:

- Freshwater fishes that inhabit freshwater only
- Marine fishes that inhabit marine waters only
- Diadromous migratory fishes that migrate between freshwater, estuarine, and/or marine waters

- o Anadromous fishes are a subset of diadromous fishes where adults occupy marine waters and enter freshwater to spawn; eggs and larvae develop in freshwater.

The Chukchi Sea features designated Essential Fish Habitat for Pacific salmon (all life stages for all five species), Arctic cod (late juvenile and adults), saffron cod (late juvenile and adults), and opilio crab (eggs) (http://www.alaskafisheries.noaa.gov/habitat/efh.htm). While this Second SEIS is not intended to provide the basis for Essential Fish Habitat (EFH) consultation, the habitats of each of these species are encompassed in the general discussion below.

Marine fish habitats are typically described in two depth (vertical) categories:

- Benthic and demersal environment (seafloor and bottom water [up to 3 m above seafloor])
- Pelagic environment (ocean surfacewaters and water column)

Fish species discussed in this section are referred to by their common names. A list of the common fish names with the corresponding taxonomic names is provided in Table 3-8. An extensive list of fish species and associated environments in the U.S. Chukchi Sea is presented in the 2011 SEIS (Appendix C, Table C-1) and is incorporated here by reference (USDOI, BOEMRE, 2011a).

Table 3-8. Common and Taxonomic Fish Names.

Fish Common Name	Taxonomic Name	Fish Common Name	Taxonomic Name
Alaska plaice	*Pleuronectes quadrituberculatus*	Hamecon	*Artediellus scaber*
Arctic alligatorfish	*Aspidophoroides olrikii*	Humpback whitefish	*Coregonus pidschian*
Arctic char	*Salvelinus alpinus*	Least cisco	*Coregonus sardinella*
Arctic cod/polar cod	*Boreogadus saida*	Longhead dab	*Limanda proboscidea*
Arctic flounder	*Pleuronectes glacialis*	Marbled eelpout	*Lycodes raridens*
Arctic shanny	*Stichaeus punctatus*	Ninespine stickleback	*Pungitius pungitius*
Arctic staghorn sculpin	*Gymnocanthus tricuspis*	Pacific herring	*Clupea pallasii*
Bering cisco	*Coregonus laurettae*	Pacific sand lance	*Ammodytes hexapterus*
Bering flounder	*Hippoglossoides robustus*	Pink salmon	*Oncorhynchus gorbuscha*
Bering wolffish	*Anarhichas orientalis*	Prickleback species	*Stichaedae*
Broad whitefish	*Coregonus nasus*	Rainbow smelt	*Osmerus mordax*
Canadian /polar eelpout	*Lycodes polaris*	Saffron cod	*Eleginus gracilis*
Capelin	*Mallotus villosus*	Sculpin species	*Cottidae*
Chinook salmon	*Oncorhynchus tshawytscha*	Shorthorn sculpin	*Myoxocephalus scorpius*
Chum salmon	*Oncorhynchus keta*	Slender eelblenny	*Lumpenus fabricii*
Coho salmon	*Oncorhynchus kisutch*	Snailfish species	*Liparis sp.*
daubed shanny	*Leptoclinus maculatus*	Sockeye salmon	*Oncorhynchus nerka*
Dolly varden	*Salvelinus malma*	Starry flounder	*Platichthys stellatus*
Eelpout species	*Lycodes sp.*	Stout eelblenny	*Anisarchus medius*
Greenland halibut	*Reinhardtius hippoglossoides*	White-spotted greenling	*Hexagrammos stelleri*
Halfbarred pout	*Gymnelus hemifasciatus*	Yellowfin sole	*Limanda aspera*

Note: Common Names and Taxonomic Names of Marine and Migratory/Anadromous Fish Species that Commonly Occur in the U.S. Chukchi Sea.

In 2004, researchers trawled depths between 34-101 m (112-331 ft) in the U.S. and Russian Chukchi Sea during the Russian-American Long-Term Census of the Arctic (RUSALCA). Four fish species comprised 79% of the total number of fish caught: Arctic staghorn sculpin, Shorthorn sculpin, Bering flounder, and Arctic cod. The researchers also examined archival fish specimens in museums. This combined survey and museum research extended ranges of known species, verified occurrence of rare species, and helped to clarify the taxonomy and number of species and families that occur in the Chukchi Sea (Mecklenburg et al., 2007).

Demersal fish species and ichthyoplankton were also collected in the U.S. Chukchi Sea and Russian Chukchi Sea waters during the summer of 2004 (Norcross et al., 2010). Thirty species of demersal fish within 10 families were collected. Sculpin species (*Cottidae*) were the most commonly caught fish. Sediment type, bottom salinity, and bottom temperature were the important factors in determining the type of demersal habitat and the fish that associated with that habitat. Ichthyoplankton occurrence was related to water temperature and salinity of the water column. This study identified four groupings of fish species in the Chukchi Sea based on ocean water mass and habitat characteristics: coastal fishes; south Central Chukchi Sea fishes; western Chukchi Sea fishes; and north Central Chukchi Sea fishes.

Pink salmon and chum salmon are the most common Pacific salmon species known to occur in the U.S. Chukchi Sea. High densities of juvenile pink and chum salmon were trawled near the surface offshore in the Chukchi Sea in September, 2007 (Moss et al., 2009); adult salmon, however, are known to occur as deep as 200 m (660 ft). Sockeye salmon and coho salmon occur in the southern Chukchi Sea but in lower numbers than pink and chum salmon. There are indications of small runs of chinook salmon in the Kugrua River, through Elson Lagoon and strays have been captured in the Kuk River, near Wainwright (Fechhelm and Griffiths, 2001; Craig and Haldorson, 1986). As climate change occurs (ice reduction, warming waters), salmon are appearing in the Chukchi Sea in greater numbers (Kondzela et al., 2009).

Beach-seine sampling and bottom trawl tows (depth <8 m (26 ft)) were conducted at six sites along the Chukchi Sea coastline during August 2007, 2008 and 2009. Most of the fish caught were juveniles. Abundance and species composition varied monthly at sites. There was also an annual variation related to water temperature and sea-ice conditions. Capelin was the most abundant fish species caught when the year was warmer, and arctic cod was more abundant when the year was colder (Thedinga, Johnson, and Neff, 2010).

Research has been published, or was initiated and is still underway, since the 2011 SEIS. This recent research in the Chukchi Sea provides new information on fish occurrence; distribution by depth and area; seasonal distribution (including the influence of sea ice on distribution); occurrence and taxonomy of ichthyoplankton; and fish community structure and composition, including oceanographic factors that are likely determinants of community structure. Some general trends can be seen across several recent studies on fish in the U.S. Chukchi Sea:

- The occurrence of adult fish species varies with depth of water and latitude.
- The occurrence of adult fish species varies with distance from shore (inner continental shelf to outer continental shelf).
- Primary factors that determine demersal fish habitat and communities appear to be salinity, temperature of bottom water, and percent gravel and mud.
- Primary factors that determine pelagic fish communities appear to be water mass characteristics and presence of preferred prey.
- Adult Arctic cod are abundant in both demersal and pelagic environments in central and northern surveys.
- The sculpin family (*Cottidae*) is commonly the most abundant family represented (up to 8 *Cottidae* species) in demersal collections.
- Adult fish in the northern and central Chukchi Sea are generally small; the representative size of demersal adult fish is less than 15 cm (less than 6 inches).
- The abundance and diversity of fish species is greater in the southern Chukchi Sea than in the northern Chukchi Sea.
- In warm, low salinity waters of the Alaska Coastal Water mass (central Chukchi Sea), juvenile saffron cod, Arctic cod, and shorthorn sculpin are abundant pelagic species. In the colder, more saline, stratified waters (southern Chukchi Sea near the Bering Strait) adult Pacific herring is a common pelagic species.

- The diversity of fish species captured along the shoreline varies as the open water season progresses.
- Several species of ichthyoplankton were collected and identified including: Arctic cod, arctic staghorn sculpin, alligatorfish, Arctic alligatorfish, Arctic shanny, daubed shanny, Alaska plaice, Bering flounder, longhead dab, yellowfin sole, and Greenland halibut.
- Demersal fish diversity over decades was highest at Bering Strait and due north into the southwestern portion of the Leased Area compared to northern and western Chukchi Sea.
- The dominant demersal fish species captured in research trawls in the U.S. Chukchi Sea remained the same over decades: Arctic cod, Arctic staghorn sculpin, shorthorn sculpin, eelpout species, saffron cod, and Bering flounder.
- The diversity of benthic fish species is high at Hanna shoal in the northeastern Chukchi Sea. Arctic cod, eelblennies, eelpouts, and snailfish are the most dominant benthic species collected.
- Dolly Varden travel from the Wulik River on the U.S. Chukchi Sea coast to the Russian Chukchi Sea outer continental shelf to feed during summer; the majority of time the fish swim close to the sea surface.
- Juvenile pink and chum salmon occur in high numbers in surface trawls.
- Several new anadromous waterbodies along the U.S. Chukchi Sea coast are documented and added to the Alaska Anadromous Waters Catalog.

A list of these recent studies of fish in the Chukchi Sea is presented in Table 3-9.

Table 3-9. Summary of Recent Research on Chukchi Sea Fish.[1]

	Program/Investigators	Date Published	Topic and Summary Concept
A	Arctic Ecosystem Integrated Survey. NMFS, UAF, and other universities, in collaboration with BOEM. Mueter, Farley, Lauth, Stevenson, Busby, Pinchuk, Weems	Interim reports: 2013-2014	Variation was found in abundance, distribution, and ecology of fish in the demersal, midwater, and surfacewater environments in the U.S. Chukchi Sea.
B	Arctic Coastal Ecosystem Survey. Boswell, Barton, Heintz, Moran, Robertson, Vollenweider, Norcross, Li	2013 and ongoing	The nearshore environment has a highly dynamic fish community composition and may be a nursery area and a corridor for several species of juvenile fish to transition to the oceanic habitat
C	Seitz and Scanlon	2014	Dolly Varden in the Chukchi Sea swim long distance migration from U.S. Wulik River to feed on the Russian Chukchi Sea outer continental shelf.
D	Norcross, Raborn, Holladay et al.	2013	Most common demersal fish in the Northeastern Chukchi Sea were Arctic cod, stout eelblenny, shorthorn sculpin, hamecon, slender eelblenny; all fish were small,<15 cm (<6 in.).
E	Norcross, Holladay and Mecklenburg	2013	Fisheries research-catch data in the eastern Chukchi Sea: dominant species of demersal fishes captured over decades were the same: Arctic cod, Arctic staghorn sculpin, shorthorn sculpin, eelpout species, saffron cod, Bering flounder.
F	Eisner et al.	2012	Pelagic fish species distribution was related to water masses with differences between warm, low salinity waters in central Chukchi Sea and colder, more saline waters in southern Chukchi Sea.
G	Grebmeier et al.	2012	Diversity of demersal fish species per-catch was high at Hanna Shoal in northeastern Chukchi Sea.

Note: 1 The results from these studies are described in A-G below.

A. Arctic Ecosystem Integrated Survey: Research cruises were conducted in 2012 and 2013 during open water seasons to study the fish and oceanography of the U.S. Chukchi Sea. The National Marine Fisheries Service (NMFS), University of Alaska-Fairbanks (UAF), and other universities, in collaboration with BOEM, investigated the abundance, distribution, and ecology of fish in the demersal, midwater, and surfacewater environments. Preliminary results are available through interim reports, presentations, and posters (Farley et al., 2014; Lauth, 2014; Mueter et al., 2013; Mueter and Weems, 2014a,b).

Arctic cod was the overall most abundant fish caught in surfacewater trawls, with very high numbers of small individuals; capelin showed the second highest total abundance in the surfacewater. Other fish species commonly caught in the surfacewater trawls included Pacific sand lance, pink salmon, prickleback species, saffron cod, Pacific herring, shorthorn sculpin, and chum salmon. Pacific herring and capelin comprised the greatest overall biomass (weight) in surfacewater trawls.

Arctic cod comprised the greatest total biomass collected over all bottom trawls; saffron cod and Pacific herring comprised the second and third largest biomass. Other abundant demersal fish species caught included: yellowfin sole, starry flounder, shorthorn sculpin, rainbow smelt, Bering flounder, Arctic staghorn sculpin, Alaska plaice, variegated snailfish daubed shanny, polar eelpout, Alaska skate, and wattled eelpout. In total, sixty-six taxa of demersal fish were caught during the two year field study.

An acoustic fish survey was conducted in September, 2013, extending from the Chukchi Sea shelf onto the continental slope and into the deeper waters of the canyon near Barrow. Older Arctic cod were found in a narrow band in the deep water (220-250 m (722-820 ft) depth) Atlantic layer of water, located just below the relatively colder water Pacific layer.

Ichthyoplankton (fish eggs and fish larvae) collected in depth-integrated plankton tows were identified: Arctic cod, arctic staghorn sculpin, alligatorfish, Arctic alligatorfish, Arctic shanny, daubed shanny, Alaska plaice, Bering flounder, longhead dab, yellowfin sole, and Greenland halibut.

B. Arctic Coastal Ecosystem Survey: Nearshore fish beach-seine sampling was conducted in August 2012 and 2013 (and continuing in 2014) by NMFS, in partnership with BOEM, and the NPRB (North Pacific Research Board). Most fish caught in beach seines were in larval or juvenile stages. The most abundant fish seined at the Chukchi Sea coastline sites were sculpin species, sand lance, capelin, and prickleback species.

Based on preliminary results, variability in fish abundance and diversity was found between beach seine sites on a weekly scale. Interannual variability was also noted when the authors compared the 2013 study results to the same sites in previous years The results to date suggest that: the Chukchi Sea nearshore environment has a highly dynamic fish community composition; the Chukchi Sea nearshore environment may be serving as a nursery area for several species of juvenile fish, as fish lengths were found to increase from July to August; and the nearshore environment may serve as a corridor for juvenile fish to transition to the oceanic habitat (Boswell et al., 2014; Johnson et al., 2012; NMFS, 2014a).

C. Dolly Varden char in the Chukchi Sea: Dolly Varden were tracked in the northeast Chukchi Sea in 2012 and 2013. Using pop-up telemetry, it was documented that individuals of this species swim long distances offshore (sometimes up to 30–60 km (19-37 mi)/day from the U.S. Chukchi Sea coastal rivers to feed during summer months on the Russian Chukchi Sea outer continental shelf of the Chukotka Peninsula. Other telemetered individuals were found to disperse from riverine habitats connected to the U.S. Chukchi Sea and move alongshore, into other rivers, or in nearshore waters of the U.S. Chukchi Sea. Dolly Varden frequently occupied relatively shallow waters less than 15 m (49 ft) deep. All tracked individuals spent the majority of their time close to the sea surface (Seitz, Courney, and Scanlon, 2014).

D. Demersal fish in the northeastern Chukchi Sea: Twenty-nine species of demersal fish from 9 families were captured in the northeastern Chukchi Sea (40-45 m (131-148 ft) depth) during open water in 2009 and 2010. The five most common demersal fish caught were: Arctic cod, stout eelblenny, shorthorn sculpin, hamecon, and slender eelblenny. Eight species from the sculpin family were caught in the study area, making sculpin species the most abundant family represented. Most of demersal fish caught were small in length, and though larger individuals were caught, the representative size of demersal fish in the study region was <15 cm (6 inches). The density and number of species collected were greater in the more southerly portion of the study area, than in the northerly portion of the study area. Arctic cod was the most abundant species in both the north and south portions of the study area. Bering flounder and Arctic staghorn sculpin, however, were found in greater numbers in the southern portion of the study area. Within the study area, small-scale differences were found among fish communities where densities, species richness, and assemblage structure varied. Salinity, bottom water temperature, and percent gravel and mud explained these differences (Norcross et al., 2013).

E. Historical and recent fisheries data in the U.S. Chukchi Sea: Historical and recent fisheries research-catch data were analyzed over 13 open-water years between 1959 and 2008 in the eastern Chukchi Sea. Notable results showed that: 1) 15 benthic and demersal fish taxa in 17 families comprised 99% of all fish captured in fisheries research over all years and gear types; 2) the dominant species of demersal fishes captured over decades were the same: Arctic cod, Arctic staghorn sculpin, shorthorn sculpin, eelpout species, saffron cod, and Bering flounder; and 3) demersal fish diversity over decades was highest at Bering Strait and due north into the southwestern portion of the Leased Area (Norcross, Holladay and Mecklenburg, 2013).

F. Pelagic species in relation to water masses: The occurrence of pelagic fish species in the southern and central Chukchi Sea during September 2007 (a warm year) was related to water masses, most likely because preferred fish prey, particularly copepods and euphausiids, were influenced by the characteristics of the distinct water masses. Juvenile saffron cod, Arctic cod (*B. saida*), and shorthorn sculpin were most abundant in warm, low salinity waters of the Alaska Coastal Water mass in the central Chukchi Sea. Pacific herring occurred more frequently in colder, more saline stratified waters of the southern Chukchi Sea near the Bering Strait. Juvenile pink and chum salmon were most commonly in the less stratified water in the central Chukchi Sea (Eisner et al., 2012).

G. Hanna Shoal study in northeast Chukchi Sea: Arctic cod, eelblennies, eelpouts, and snail fish were the dominant benthic species collected in trawls across Hanna Shoal in the northeastern Chukchi Sea in 2012 (Grebmeier et al., 2012). The diversity of fish species per catch was high. The density per catch was relatively low. The fish caught were small (<10 cm, <4 inches).

Anadromous Salmon

Juvenile pink salmon and chum salmon were abundant in surface trawls in August 2012 and 2013 in the Chukchi Sea offshore from Cape Lisburne and Cape Espenberg. Juvenile sockeye salmon were captured in 2012 offshore of Cape Espenberg in 2012 (NMFS, 2012; Mueter et al., 2012). Pink salmon and chum salmon are the most commonly reported anadromous species in the Alaska Arctic north of Point Hope (Nielsen, Ruggerone, and Zimmerman, 2012).

Nearshore fish sampling was conducted at sites along the northern Chukchi Sea coastline during August 2007, 2008, 2009 and 2012 to describe distribution and relative abundance of nearshore fish. Adult pink salmon were observed during the 2008 beach seine sampling (Thedinga, Johnson, and Neff, 2010) and salmon smolts were captured in beach seining in August, 2012 (Boswell et al., 2014).

Alaska Department of Fish and Game maintains the Anadromous Waters Catalog of Alaska (AWC). Each year the AWC is updated with records of anadromous waters and species (Johnson and Daigneault, 2013; ADF&G, 2014a). Since 2011, the AWC listed 9 new anadromous waters (primarily for pink and chum salmon) along the Chukchi Sea coastline (Table 3-10).

Table 3-10. Anadromous Waters-New AWC Records Since 2011.

Records Added since 2011	Anadromous Species and Life Stage	General Location of Waterbody
Kaolak River	Chum salmon, spawn	Wainwright, Kuk River Basin
Avalik River	Chum salmon, present; Pink salmon present	Wainwright, Kuk River Basin

Records Added since 2011	Anadromous Species and Life Stage	General Location of Waterbody
Ketik River	Chum salmon, spawn; Pink salmon, present	Wainwright, Kuk River Basin
Avak Creek	Sockeye salmon, present; Broad Whitefish, present; Least cisco, present	Pt Barrow, Elson Lagoon
Ikroagvik Lake	Sockeye salmon, present; Broad Whitefish, present; Least cisco, present	Pt Barrow, Elson Lagoon
Unnamed Trib. in Kuk River Basin	Chum salmon, spawn	Wainwright, Kuk River Basin
Unnamed Trib. in Kuk River Basin	Least cisco, present	Wainwright, Kuk River Basin
Unnamed Trib.in Kuk River Basin	Least cisco, present	Wainwright, Kuk River Basin
Reed River	Chum salmon, present and rearing	Kotzebue Sound, Kobuk River Basin

Note: New Records of Anadromous Waters Added to the (ADF&G) Anadromous Waters Catalog (AWC) Since 2011
Source: ADF&G, 2014a

In addition to new anadromous waters added to the AWC by ADF&G since 2011, documentation of 20 new anadromous fish and new life stages occurrences were added to waters already existing in the AWC (Table 3-11).

Table 3-11. Fish Species and Life Stages Added to AWC Waterbodies since 2011.

Existing Records of Anadromous Waters in AWC as of 2011	New Records of Fish Species and Life Stages Added to Existing Waters in AWC since 2011	General Location of Waterbody
Kuk River	Chum salmon, present; Bering Cisco, present; Least cisco, present; Rainbow smelt, present	Wainwright, Kuk River Basin
Kungok River	Chum salmon, present; Bering Cisco, present; Least cisco, present; Rainbow smelt, present	Wainwright, Kuk River Basin
Mikigealiak River	Chum salmon, spawning; Least cisco, present	Wainwright, Kuk River Basin
Rathlatulik River	Chinook salmon, spawning and rearing	Norton Sound, Fish River Basin
North Fork Rathlatulik River	Chinook salmon, rearing, Coho salmon, rearing	Norton Sound, Fish River Basin
Kiwalik River	Dolly Varden, present	Kotzebue Sound, flows directly into Sound
Niukluk River	Chinook salmon, rearing; Coho salmon, rearing; Pink salmon, rearing	Norton Sound, Fish River Basin
Inglutalik River	Pink salmon, spawning; Chum salmon, spawning	Norton Sound, flows directly into Sound
Mauneluk River	Chum salmon, present and rearing	Kobuk River Basin

Note: New Records of Species and Life Stages Added to Existing Waterbodies in the Alaska Department of Fish and Game (ADF&G) Anadromous Waters Catalog (AWC) Since 2011.
Source: ADF&G, 2014a

Several freshwater fish occur in the rivers, streams, lakes, and ponds that are in the area from the Chukchi Sea coastline and eastwards. Although these fish are identified as freshwater species, grayling, sheefish, burbot, and slimy sculpin also venture into brackish waters at times and may be found in lagoons, bays, and river mouths along the coast. Table 3-12 presents the common and taxonomic names of fish species that inhabit these waters.

Table 3-12. Freshwater Fish that Enter Brackish Waters in the SEIS Analysis Area.

Common Name	Taxonomic Name
Grayling	*Thymallus arcticus*
Round whitefish	*Prosopium cylindraceum*
Sheefish	*Stenodus leucichthys*
Lake trout	*Salvelinus namaycush*
Burbot	*Lota lota*
Northern pike	*Esox lucius*
Alaskablackfish	*Dallia pectoralis*
Slimy sculpin	*Cottus cognatus*

Note: Freshwater Fish (which commonly venture into brackish waters) that Inhabit Waters in the SEIS Analysis Area.

3.2.3. Marine and Coastal Birds

Most birds occurring in the Chukchi Sea area are present on a seasonal basis. The southern Chukchi Sea is known to have seasonally high densities of birds at sea and at seabird colonies (USFWS, 2014f). 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 Leased Area twice each year. Departure times from the Beaufort and Chukchi Seas during postbreeding or fall migration vary between species and often by sex or age within the same species, but most marine birds will have moved out of the Chukchi Sea by late fall, i.e., November (USDOI, BOEM, 2014b) before the formation of sea ice. The following sections summarize movement patterns, locations, and life history characteristics for several key avian groups.

3.2.3.1. Threatened and Endangered Marine and Coastal Birds

This section provides information on species currently listed as Threatened or Endangered or species that are candidate species under the ESA.Threatened and endangered species in the Chukchi Sea Planning Area include the spectacled eider *(Somateria fischeri)* (threatened) and Steller's eider *(Polysticta stelleri)* (threatened). These species are known to seasonally occur in the Chukchi Sea OCS.

Full descriptions of each species are provided in the BOEM 2011 Biological Evaluation (BE) (USDOI, BOEMRE, 2011b). Full descriptions of each species are also provided in the USFWS 2012 Biological Opinion (USFWS, 2012). Summary descriptions are provided below.

Spectacled Eider

The spectacled eider was listed as a threatened species under the ESA in 1993 (58 *FR* 27474, May 10, 1993). 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 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 (LBCHU) 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 km^2 (0.37 mi^2) (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, February 6, 2001). The critical habitat area includes the waters of Ledyard Bay within about 74 km (45 mi) from shore, excluding waters <1.85 km (~1.1 mi) from shore. 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 (19-25 mi) 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.

Stehn, Larned, and Platte (2013, page 8) reported that from 1992-2012, the growth rate spectacled eiders as indicated by aerial surveys was 0.990 (SE = 0.0081, 90% c.i. = 0.9767-1.0035), a slightly decreasing trend. They cautioned, however, that any conclusion on whether this population trend is significantly different from stable (growth rate = 1.0) depends on various assumptions such as appropriateness of the regression model, adequacy of the estimated variance, statistical theory of null hypothesis testing, or which subset or number of years are included in the analysis. For the purposes of analysis, BOEM considered the population trend to be stable.

Steller's Eider

The Alaska-breeding population of Steller's eiders is listed as threatened 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; USFWS, 2002).

Less than 5% of the breeding population of Steller's eiders nests in Arctic Alaska (Rothe and Arthur, 1994). Over 95% of the Alaska-breeding Steller's eiders occur on the ACP near Barrow (USFWS, 1999, 2002; Quakenbush et al., 2004). The USFWS 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 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 (USFWS, 2007).

Breeding 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, Alaska-breeding Steller's eiders stop and rest in areas of the Alaska Chukchi Sea, often in nearshore waters (within 2 km or 1.3 mi of shore) near Ledyard Bay and Icy Cape. There is less use at more northerly locations near Wainwright and Peard Bay.

Other information

The USFWS determined that listing the Kittlitz's murrelet *(Brachyramphus brevirostris)* as threatened or endangered under the ESA was not warranted and it is no longer a candidate species for ESA consideration (78 *FR* 61764, October 3, 2013). The Kittlitz's murrelet is evaluated under Other Marine and Coastal Birds (Section 3.2.3.2) in this Second SEIS.

The USFWS determined that listing the yellow-billed loon *(Gavia adamsii)* as threatened or endangered under the ESA was not warranted and it is no longer a candidate species for ESA consideration (79 *FR* 59195, October 1, 2014). The yellow-billed loon is evaluated under Other Marine and Coastal Birds (Section 3.2.3.2) in this Second SEIS.

The endangered short-tailed albatross *(Phoebastria albatrus)* was observed near the Lease Area in the Chukchi Sea in August 2012 (Day et al., 2013), and although this was a first record of any albatross species in the Chukchi Sea, the short-tailed albatross may be using the northern Bering Sea more in recent decades. It is the more northerly of the three North Pacific albatrosses, and with a growing population, it might be reoccupying its historic range.

3.2.3.2. Other Marine and Coastal Birds

Cliff-Nesting Seabirds

Common murres and thick-billed murres

Common murres *(Uria aalge)* and thick-billed murres *(Uria lomvia)* breed as far north as Cape Lisburne and farther south at Cape Thompson (USFWS, 2014d). Common murres are primarily piscivorous and rely on dispersed schools of offshore fish. The diet of thick-billed murres can sometimes be dominated by euphaussids, which are abundant in areas of the eastern Chukchi in late summer/fall (Gall, Day , and Weingartner 2013, Kultez et al. in press). Based on limited data, murre foraging areas overlap with the area considered in the Leased Area (USDOI, MMS, 2007a, 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 *(Fratercula corniculata)* and the tufted puffin *(Fratercula cirrhata)* are found in the Chukchi Sea area, where they breed in colonies. The USFWS (2014d) 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 (62 mi) offshore of breeding colonies (Hatch et al., 2000).

Black-legged kittiwake

Black-legged kittiwakes (*Rissa tridactyla)* are surface foragers that are primarily piscivorous, but also consume large zooplankton, including euphausiids. 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 (USFWS, 2005). Divoky (1987) reported black-legged kittiwakes were abundant from mid-July until late September in the Chukchi Sea north of Cape Thompson, and recent studies in the Lease Areas (Gall and Day, 2012) in 2008-2010 found that kittiwakes were usually most abundant in August and early September, but did occur in the area in late September-early October. Kittiwakes range far offshore through most of the area considered for the lease sale (Gall et al. 2013, Kuletz et al. 2015). Divoky (1987) estimated over 400,000 black-legged kittiwakes in the pelagic Chukchi Sea, but there is no recent estimate for total numbers in the region. A substantial portion of this population occurs in the Leased Area in the open-water season.

Bering Sea Breeders and Summer Residents

The BOEM Environmental Studies Program in the Chukchi Sea since 2008 included pelagic bird surveys (Gall and Day, 2012). These surveys were focused over specific hydrocarbon prospects (Klondike, Burger, and Statoil) and provided relatively fine-grained or site-specific information on the distribution and abundance of marine and coastal birds during the open water period. At-sea population densities of marine and coastal birds were typically low in these areas, which is consistent with earlier interpretations in the 2011 SEIS. The northern fulmar, auklets, and the short-tailed shearwater can occasionally occur in large concentrations, likely in response to dense patches of prey in the ocean. The timing and location of these bird and prey concentrations cannot be predicted with any certainty although some features, such as Barrow Canyon and southern Hanna Shoal area, consistently appear to have seasonally abundant prey that attracts top predators (Ashjian et al., 2010, Grebmeier et al., 2006), including seabirds (Kuletz et al.,2015).

Kittlitz's murrelet

Kittlitz's murrelet may nest as far north as Cape Beaufort (100 km (62 mi) northeast of Cape Lisburne) in the Amatusuk Hills. Observations of breeding Kittlitz's murrelets are sparse along the U.S. Chukchi Sea 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; Day et al., 2011). These birds are solitary nesters.

Kittlitz's murrelet is a small diving alcid that consumes fish and large zooplankton. Their foraging areas may occur in or near the Leased Area. Kittlitz's murrelets have been observed on a regular basis in the Chukchi Sea as far north and east as Point Barrow and is widespread throughout the Chukchi Sea in late summer and fall (Bailey, 1948, Divoky 1987, Day et al. 2011). Although rare in the Beaufort Sea, it has been recorded there (USFWS, 2006, Day et al. 2011). Highest densities in the Chukchi Sea have been recorded in the fall within 50 km (31 mi) of shore (Day et al. 2011), although high densities (considered 'hotspots') have also been recorded in fall in the Hanna Shoal area (Kuletz et al.2015).

Northern fulmar

The northern fulmar *(Fulmarus glacialis)* 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.

Gall and Day (2012, Figure 13) and Gall et al. (2013) could not ascertain a consistent pattern in northern fulmar abundance among study areas in the Chukchi Sea, 2008-2012. The abundance of northern fulmars differed significantly among seasons in all years. The seasonal pattern of abundance was consistent among study areas, although fulmar densities were much higher in summer of 2009, when warm Bering Sea water flooded the study area (Gall et al. 2012). Northern fulmars were present in low abundance (<0.5 birds/km^2) (<0.5 birds/0.39 mi^2) in the Leased Areas, and were most numerous from late August to mid-September. Flocks totaling in the low hundreds were observed during the late summer and early fall around the Klondike and Burger prospects during seabird surveys (Gall and Day, 2012). An analysis of four decades of pelagic surveys in the Bering Sea found that northern fulmars have shifted the center of their distribution north in recent decades, and at-sea densities show evidence of decline in the Bering Sea (Renner et al. 2013). Although this analysis did not include the Chukchi Sea, it could indicate occasionally greater use of those northern waters as well.

Short-tailed shearwater

The short-tailed shearwater *(Ardenna tenuirostris)* in the Chukchi Sea are most common in the southern portion, and are routinely found in the Leased Area from late August to late September. At northern latitudes, short-tailed shearwaters likely forage on dense patches of euphausiids and amphipods.

Short-tailed shearwaters were the second most-abundant species during five years of surveys, primarily because of large flocks moving through in September (Gall and Day, 2012, Figure 13). As with other seabirds, short-tailed shearwater abundance differed significantly among study areas, seasons, and years.

Gall et al. (2012) suggested that the shearwaters can rapidly respond to changes in oceanic conditions and exploit food resources when and where they are available. For example, Kuletz (2011) reported a single flock numbering over 15,000 short-tailed shearwaters in the western Beaufort Sea in late August–early September, 2011. Kuletz (2011) reported over 4,000 shearwaters during a seabird survey in the Chukchi Sea in late August – early September 2011 (the most abundant species reported), with many flocks numbering between 150-300 birds. These observations were consistent with those of Bankert (2012). Similarly, flocks totaling in the low hundreds were observed during the early fall around the Klondike, Burger, and Statoil prospects during seabird surveys in 2008-2012 (Gall and Day, 2012); however, during the early fall period in 2009, almost 12,000 short-tailed shearwaters were observed near the Klondike Prospect. Areas of especially high densities of short-tailed shearwater occurred in summer and fall (2007-2012) over Barrow Canyon and Hope Basin, and off of Wainwright (summer) and Point Hope (fall); all of these areas of high density were within the 50 m contour (Kuletz et al., 2015.

Auklets

Three species of auklets, (parakeet, least, and crested) breed as far north as the Bering Strait (USFWS, 2014f), but move into the Chukchi Sea, including much of the Leased Area, from late August into early October.

Crested auklets *(Aethia cristatella)* were the most abundant species recorded during recent pelagic seabird surveys in the Chukchi Sea (Gall and Day, 2012, Tables 5–9). Abundance differed significantly among study areas, seasons, and years, although the patterns were not consistent. The auklets had the lowest density in 2008 (mean abundance: 0.0–5.2 birds/km²) (0.0-5.2 birds/0.39 mi^2), and highest density in 2009 (mean abundance: 0.1–30.2 birds/km²) (0.1-30.2 birds/0.39 mi^2). Seasonal patterns of abundance among study areas also differed among years.

Abundance of least auklets *(Aethia pusilla)* differed among offshore study areas, seasons, and years, although the patterns were not consistent (Gall and Day, 2012). Least auklets were more abundant in 2012 than in any of the previous four years (Gall and Day, 2012, Figure 11, Tables 5–9); however, there was no consistent trend in abundance among seasons or study areas.

The Hanna Shoal area may be an important molting area for crested auklets (Grebmeier, 2012a). During surveys from 2007-2012 (combined), very high densities of crested auklets were found in the Hanna Shoal area in summer and fall (Kuletz et al. in press). Least auklets were in the Hanna shoal area in summer, and in Hope Basin in summer and fall (Kuletz et al.,2015).

High Arctic-Associated Seabirds

Black guillemot

Black guillemot *(Cepphus grylle)* 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 (Ainley and Divoky, 2001).

Ross's gull

Ross's gulls *(Rhodostethia rosea)* may be encountered along the coast and offshore waters of the Beaufort and Chukchi Seas, including in the winter months. 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 *(Pagophila eburnea)* 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 *(Sterna paradisaea*) 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 community of Point Lay. It has a wide, circumpolar breeding distribution. In Alaska, it nests along the coasts of the Chukchi and Bering Seas.

Tundra-Breeding Migrants

Jaegers

The three species of jaegers (*Stercorarius)* (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 *(Larus hyperboreus)* 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 (43 mi) 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).

Yellow-billed Loon

Yellow-billed loons typically nest on low islands or narrow peninsulas on the edges of large, deep, tundra lakes. Breeding yellow-billed loons typically remain on their lakes until young are fledged.

The yellow-billed loon was considered relatively rare in the U.S. Arctic region. Dau and Bollinger (2009) reported an average of fewer than 50 yellow-billed loons during late-June surveys of the coast and barrier islands between Omalik Lagoon and the Canadian Border (2005-2009).

Of the approximately 3,300 yellow-billed loons present on the breeding grounds on the North Slope, primarily between the Meade and Colville Rivers in the National Petroleum Reserve in Alaska (NPR-A), it is likely that there are fewer than 1,000 nesting pairs because some of the 3,300 are nonbreeders. Additionally, there are approximately 1,500 yellow-billed loons (presumably juvenile nonbreeders) that remain in nearshore marine waters or in large rivers during the breeding season. In total, there are fewer than 5,000 yellow-billed loons on the Arctic coast breeding grounds and near shore marine habitat (Earnst et al., 2005). There may be approximately 1,500 yellow-billed loons, presumably non-breeding adults and immatures, in nearshore marine waters or in large rivers during the breeding season. Yellow-billed loon numbers were thought to be declining (74 *FR* 12932, March 25, 2009), but the population is now considered stable or slightly increasing (Stehn, Larned, and Platte, 2013, p. 23).

Most yellow-billed loons from the ACP have moved into nearshore coastal waters by September. In addition, approximately 8,000 yellow-billed loons from the Canadian Arctic travel across the Chukchi Sea during spring and fall migration between Canada and wintering grounds in eastern Asia. In another BOEM-funded study, Rizzolo and Schmutz (2010) found most yellow-billed 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.

Low numbers, patchy distributions, and specific habitat requirements may make yellow-billed loons more susceptible to environmental perturbations than other loon species that are more abundant, widely distributed, and able to exploit a greater diversity of habitats.

Waterfowl

Loons

Pacific loons *(Gavia pacifica)* 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 requirements 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 *(Clangula hyemalis)* is a common species in the Chukchi Sea after the first week of September until late October. Typical migration distances offshore for long-tailed ducks, as well as other species, are along the 20-m (66 ft) 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).

Aerial surveys along coastal habitats of the entire ACP typically observe fewer than 7,500 long-tailed ducks, with about two-thirds of these associated with mainland habitats (Dau and Bollinger, 2009). Stehn, Larned, and Platte (2013) re-evaluated long-tailed duck survey data along the ACP from 1986-2012. The average indices range from 43,000-52,000 with calculated growth rates near 1.0 (Stehn, Larned, and Platte, 2013, p. 38).

Common eider

The common eider *(Somateria mollissima)* typically migrates during spring along the Chukchi Sea coast using offshore open-water leads. 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).

Dau and Bollinger (2012) estimated flat annual growth rates for indicated breeding pairs (0.1%/year, r=0.014 and -3.2%/year, r=0.325) for totals of common eiders breeding along the ACP - Alaska. Stehn, Larned, and Platte (2013) re-evaluated common eider survey data along the ACP from 1986-2012. Common eider indices (individual breeding birds and indicated total birds) were increasing (growth rate >1.0) for the 1986-2012 and the 2003-2012 periods.

King eider

Most king eiders *(Somateria spectabilis)* begin to migrate through the Chukchi Sea during spring and arrive in the Beaufort Sea by the middle of May (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, Taylor, and Lanctot (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.

Stehn, Larned, and Platte (2013) re-evaluated survey data along the ACP from 1986-2012. King eider indices for individual breeding birds and indicated total birds were increasing and had growth rates >1.0 for the years 1986-2012 (growth rate: 1.031; 90% c.i. 1.021-1.041) and 2003-2012 (growth rate: 1.024; 90% c.i. 1.011-1.037).

In a recent BOEM-funded study, Oppel, Dickson, and Powell (2009) reported substantial numbers of satellite-tagged king eiders using Ledyard Bay.

Brant

Many brant geese *(Branta bernicla)* migrate along the west coast of Alaska enroute 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; Ritchie et al., 2012)). Kasegaluk Lagoon also is an important stopover location during postbreeding migration.

Greater white-fronted goose

In northern portions of Alaska, greater white-fronted geese *(Anser albifrons)* typically breed within 30 km (19 mi) 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 1989–1991, Johnson, Wiggins, and Wainwright (1992) observed as many as 4,205 white-fronted geese during one aerial survey of Kasegaluk Lagoon; the peaks of migration out of Kasegaluk lagoon appeared to be in the first week of June and the last week of August.

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 (37 mi) south of Point Lay) in the southern portion of Kasegaluk Lagoon, one of two consistently used nesting colonies for lesser snow geese (2007 FEIS, Section III.B.5.f(7)).

Tundra swans

Tundra swans *(Cygnus columbianus)* 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 ACP 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 and south along the Chukchi Sea coast, stopping at high-productivity sites to replenish energy reserves and rest.

The Alaska Shorebird Group revised the Alaska Shorebird Conservation Plan (ASG, 2008); however, the information relied upon in the 2008 ASCP remains essentially unchanged from the 2004 version.

Phalaropes

Both red *(Phlaropus fulicarius)* and red-necked phalaropes *(Phalaropus lobatus)* are present in the Chukchi Sea during the open-water periods. Phalaropes are common in pelagic waters as well as within a few meters of shore. 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 (Johnson, Wiggins, and Wainwright, 1992). Based on ground observations, red phalaropes are considered more common than red-necked phalaropes in Peard Bay and Kasegaluk Lagoon (Kinney, 1985). 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 dunlins *(Calidris alpina)* 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 Leased Area. On the North Slope, raptors typically are more common within 20 km (12 mi) 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 most commonly encountered raptor near Kasegaluk Lagoon.

Therrien, Gauthier, and Bêty (2011) described how snowy owls (*Bubo scandiaca*) venturing out over pack ice should be considered a marine species. A recent Geological and Geophysical permittee reported one or more snowy owls on their seismic survey vessels as far as 246 mi offshore in the

Chukchi Sea in October 2013, the open-water season (Schroeder, 2014). Similarly, Gall and Day (2012) reported a short-eared owl (*Asio flammeus*) at the Burger prospect in August 2009, at least 60 mi from shore.

Passerines

Vessels operating in marine environments often encounter marine and coastal birds when the birds are migrating.

Large numbers of passerines interact with at-sea oil and gas industry vessels, often hundreds of miles from the closest landfall. During an exploration drilling program in 2012, nine species (eastern yellow wagtail, *Motacilla tschutschensis*; American pipit, *Anthus rubescens*; yellow warbler, *Dendroica [Setophaga] petechia*; Arctic warbler, *Phylloscopus borealis*; northern wheatear, *Oenanthe oenanthe*; Swainson's thrush, *Catharus ustulatus*; dark-eyed junco, *Junco hyemalis*; rusty blackbird, *Euphagus carolinus*; and a "sparrow" (Family *Passeridae*), four birds were described as a "warbler" (a vague term that could be applied to any number of small perching birds), and nine other birds (that were not or could not be identified to species) were (based on photographs) included in the passerine group (Schroeder, 2013). In addition to some of those species documented on industry vessels in 2012, another passerine species (Siberian accentor, *Prunella montanella*) was observed on an industry vessel in 2013. Entire Alaska-breeding populations of many perching birds are moving/migrating across the Arctic Ocean and Bering Sea during the open water season.

3.2.4. Marine Mammals

This section provides information on species currently listed as Threatened or Endangered or species that are candidate species under the ESA that may be present in or near the Leased Area. Threatened and endangered marine mammal species in the Chukchi Sea Planning Area include the bowhead whale, fin whale, humpback whale, ringed seal, and polar bear. Pacific walrus, while not currently listed under the ESA, is a candidate species, and will be considered here.

On December 28, 2012, the NMFS listed the Beringian Distinct Population Segment (DPS) of bearded seal as threatened under the ESA *(FR* 77(249):76739-76768 2012), an action that was later vacated in Federal Court on July 25, 2014 (Alaska Oil and Gas Association v. Frank Pritzker, et al., 2014 Memorandum Decision 4.13-cv-00018-RRB-1. 1:32).

Seven other species of marine mammals (including the Pacific walrus) occur in the Chukchi Sea that are not currently listed as endangered or threatened under the ESA. The information that follows is in addition to the full descriptions of these species that are provided in the 2007 FEIS (Sections III.B.4.a and III.B.6) and the 2011 SEIS (Sections III.B.4 and III.B.6).

Cetaceans

Beluga Whale

Aerial Surveys of Arctic Marine Mammals (ASAMM) during 2013 noted beluga whales *(Delphinapterus leucas)* in the Chukchi Sea during all of the months of the survey, though sightings were few and scattered (Clarke et al., 2014). Beluga whale sighting distribution was consistent with observations from previous years, indicating a preference for feeding along the continental shelf break and deeper waters over Barrow Canyon (Shelden and Mocklin, 2013).

Bowhead Whale

Bowhead whales *(Balaena mysticetus)* are uncommon in much of the Chukchi Sea, between the spring and fall migrations. During the fall migration, many pass through the Leased Area enroute to feeding grounds off the Chukoktkan coast and in the Bering Sea.

In recent years, several 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. The most recent population estimate (Givens et al., 2013) assessed the BCB bowhead stock size at 16,982 in 2011 (95% CI: 15,704 – 18,928), back-casting the stock's annual rate of increase to 3.7% (95% CI: 2.8%-3.7%). Such numbers are consistent with previous findings and indicative of low risks to the stock from subsistence whaling.

Potential Biological Removal (PBR) is defined by the MMPA as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population. It is the product of the minimum population estimate of the stock; one-half the maximum theoretical or estimated net productivity rate of the stock at a small population size; and a recovery factor of between 0.1 and 1.0. The PBR for bowhead whales of the Western Arctic Stock is 103 individuals annually (Allen and Angliss, 2013).

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 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 profiler data that infer upwelling and zooplankton aggregation in the western Beaufort Sea Shelf in this same area.

Quakenbush, Small, and Citta (2013) identified six feeding concentration areas for bowhead whales in the western Arctic. These feeding hotspots are used seasonally with core areas located near Cape Bathurst, Tuktoyuktuk, Barrow, northern Cukotka, the Strait of Anadyr, and the Gulf of Anadyr. Though bowhead whales may be found throughout the Beaufort and Chukchi Seas during the open water season, and some individuals travel long distances, most concentrate their activity in and around the six core areas according to the season and food availability. Based on the movements and behavior of tagged whales, Quakenbush, Small, and Citta (2013) identified core feeding areas as the areas where the potential for anthropogenic disturbances to affect bowhead whales is greatest.

Rugh et al. (2014) noted evidence of habitat partitioning among bowhead, beluga, and gray whales when all species were represented on the feeding grounds near Barrow. Bowhead whales preferred feeding in continental shelf waters <50 m (<164 ft) deep, and in the core areas where temperatures and water movements make prey most available (Quakenbush, Citta, and Small, 2014). Though copepods, amphipods, mysids, and euphasids were most common in prey items noted in stomach content analyses on subsistence-harvested bowhead whales, shrimp and fish also appeared prominently in the stomachs of whales harvested at St. Lawrence Island, Barrow, and Kaktovik (Sheffield and George, 2014).

The use of aerial, satellite, and passive acoustic surveys (Berchok et al., 2013; Delarue et al., 2009b ; Quakenbush et al., 2013; Quakenbush, Small, and Citta, 2013, 2014) provide additional data defining spring and late fall-early winter migration routes. Quakenbush, Small and Citta (2013, 2014) indicated that all satellite tagged whales travelled through the Leased Area, with most c. cwhales quickly transitioning through. Such studies generally confirm bowhead whale migratory habits and corridors are loosely defined and subject to interannual variability. Clarke et al. (2014) noted several bowhead whale observations in the northeastern Chukchi Sea during the open water season, except during October, when no surveys were conducted. The last bowhead whales observed by Clarke et al. (2014) in the western Beaufort Sea were seen on September 30, 2013, during the last survey of the year, between 250-400 km (155-249 mi) west-northwest of Barrow, Alaska.

Fin Whale

NMFS (2013b) categorized low densities of fin whales *(Balaenoptera physalus)* as regularly occurring in the Chukchi Sea. Passive acoustic surveys have detected fin whales offshore of Cape Lisburne and in a few other locations (Delarue et al., 2012). In 2013, there were three aerial sightings of fin whales in the vicinity of Cape Lisburne, and another fin whale was observed by vessel-based oceanographic surveys in the northeastern Chukchi Sea in 2013 (Clarke et al., 2014). Fin whales found in the Chukchi and Beaufort Seas are most likely from the northeast Pacific stock, with a minimum population size of 5,700, and a PBR of 11.4 individuals annually (Allen and Angliss, 2013).

Gray Whale

The eastern Pacific stock (EPS) of gray whales *(Eschrichtius robustus)* is has a minimum population estimate of 18,017 (Carretta et al., 2013). Though most gray whales from the EPS migrate to the Chukchi Sea during summer, some remain in feeding grounds near Kodiak Island and a few migrate to waters off the coast of Kamchatka, where they mix with the western Pacific stock (WPS) of gray whales. Satellite tagging studies during 2011 tracked two EPS gray whales migrating from the vicinity of Sakhalin Island, with one whale swimming to southern Vancouver Island where a tag was lost, and the other to Santa Barbara, California. Genetic information (Lang et al., 2010 as cited in Carretta et al., 2013) support some level of cohabitation of the western Pacific by gray whales from the EPS and the WPS (Carretta et al., 2013).

During 2013, Clarke et al. (2014) observed 174 sightings of 281 gray whales; fewer than in their 2012 survey when 310 sightings of 558 gray whales were made. Whales primarily occurred within 50 km (31 mi) of shore between Icy Cape and Point Barrow, with scattered appearances in other areas out to over 220 km (137 mi) west of Barrow. Most of the highest fine-scale sighting rates occurred between Barrow and Point Franklin and the offshore area northwest of Wainwright, Alaska. Gray whales were mostly absent from the Hanna Shoal area; some were seen south of Point Hope, Alaska. The greatest number of gray whale sightings from ASAMM flights occurred in water depths less than 35 m (115 ft) deep, and in 2012 and 2013, gray whale calf sighting rates were at least three times that of previous years, indicating survival and/or calving rates may be increasing (Clarke et al., 2013, 2014).

Aerts et al. (2013b) noted most of their gray whale observations occurred within 50 km (31 mi) of Wainwright, Alaska (an area that had a high amphipod biomass), and that gray whale distribution tends to be highly correlated with amphipod biomass distribution. Delarue et al. (2012) made the greatest number of gray whale acoustic detections in the inshore areas between Barrow and Icy Cape, supporting the observations made by Clarke et al. (2012, 2013). The Bowhead Whale Feeding Ecology study (Rugh et al., 2014) detected gray whales using the 50 m (164 ft) water depths around Barrow Canyon shelf break to feed on benthic invertebrates, an area intermediate in depth between the deep waters beluga whales use and the shallower waters and krill trap areas used by bowhead whales.

Harbor Porpoise

Harbor porpoises *(Phocoena phocoena)* have been observed throughout the Chukchi Sea, north to the Barrow Canyon area, and these individuals are believed to belong to the Bering Sea Stock. This stock has a population estimate of 48,215 based on corrected numbers from a 1999 survey, and a minimum population estimate of 40,039. Mortality sources include predation from killer whales, occasional entrapment in subsistence fisheries, and commercial fisheries (which has a 0.53 average annual take) (Allen and Angliss, 2013).

Most harbor porpoises occur in waters less than 100 m (328 ft) deep. They are found in bays, tidal areas, and river mouths. Some are regularly seen north of Barrow, Alaska (Aerts et al. 2013b), and there are undocumented reports from Point Lay residents of very large pods in the vicinity of Point

Lay, Alaska from time to time. The low numbers of harbor porpoises detected during marine mammal monitoring in the Leased Area suggest that harbor porpoises prefer shallow coastal areas.

Humpback Whale

Humpback whales *(Megaptera novaeangliae)* are occasionally observed in the Leased Area and are frequently encountered in the southern Chukchi Sea to 69°N Latitude (Clarke et al., 2014); they have been seen and heard with some regularity in recent years (NMFS, 2013b). Humpback whales found in the Chukchi and Beaufort Seas are most likely from the western north Pacific stock, with a minimum population size of 732, and a PBR of 2 individuals annually (Allen and Angliss, 2013).

Killer Whale

Killer whales *(Orcinus orca)* occurring in the Chukchi Sea are assumed to belong to the Gulf of Alaska, Aleutian Island, and Bering Sea Transient Stock, which has a minimum population estimate of 552 (Allen and Angliss, 2013). Sources of mortality among killer whales include injuries accrued during hunts, social/territorial disputes, and commercial fisheries interactions which account for an average of 1.49 annual mortalities with this stock. 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. In 2012, acoustic detectors picked up widespread killer whale vocalizations throughout the summer in the Chukchi Sea, with concentrations off Cape Lisburne, Point Lay, and over the Burger prospect (Aerts, 2013b; Delarue et al., 2013). During 2012, ASAMM survey flights detected a group of 13 killer whales around 10 km (6 mi) northwest of Barrow, Alaska, and a group of five killer whales 18 km (11 mi) northwest of Point Hope, Alaska (Clarke et al., 2013). Killer whales found in the Chukchi Sea actively hunt marine mammals, and their presence is assumed to reflect prey availability.

Minke Whale

NMFS estimates a population of 810 of the Alaska Stock of minke whales *(Balaenoptera acutorostrata)* in the central eastern and southeastern Bering Sea, and 1,233 for the Gulf of Alaska to the Central Aleutian Islands (Allen and Angliss, 2013). They have rarely been taken in subsistence whaling and usually experience no direct mortalities from commercial fishing activities. Though there have been occasional vessel strikes, the stranding data for vessel strikes and similar mortalities amounts to 0.2 minke whales in the 2006-2010 timeframe (Allen and Angliss, 2013).

Aerts et al. (2013b) noted minke whales are common in the Bering Sea and the southern Chukchi Sea and they have been seen in low numbers south of 71.3°N. In 2011, ASAMM surveys observed minke whales as far north as 71.89°N in the Chukchi Sea (Clarke et al., 2012), with similar occurrences in 2012 in the nearshore area (Clarke et al., 2013), and 2013 near Icy Cape, Point Lay and Cape Lisburne (Clarke et al., 2014).

Ice Seals

In 2011, some pinnipeds in the Chukchi Sea started manifesting symptoms of illness including ulcerated skin, hair loss, delayed molting, lethargy, labored breathing, and reduced thymus. By December 2011, over 100 pinnipeds from northern and western Alaska had been affected (NMFS, 2014b, flier 1). NMFS (2014b) announced the continuation of the Unusual Mortality Event (UME) investigation for ice seals; however, no further instances of afflicted animals have been documented since spring of 2012. Some individual ice seals with healing lesions have been documented in Norton Sound and the Bering Sea; these are recovered individuals (NMFS, 2013c).

Beringia Bearded Seal DPS

The present population of the Beringia DPS of bearded seals *(Erignathus barbatus nauticus)* has been estimated to number approximately 155,000 individuals. This population estimate is based on extrapolation from existing aerial survey data, and therefore, contains an element of uncertainty

(Allen and Angliss, 2013). Although the NMFS population estimates have uncertainties, the numbers involved are sufficient to ascertain the effects of the Proposed Action. The Beringia DPS of bearded seal range from Novosibirskiye, Russia in the East Siberian Sea, south into the Bering Sea, and east to 122°W longitude. Using studies by Ver Hoef , London, and Boveng (2010) and Bengtson et al. (2005), Cameron et al. (2005) estimated 125,000 bearded seals in the Bering Sea and another 27,000 in the Chukchi Sea, which led to a Beringian bearded seal DPS size estimate of approximately 155,000 individuals.

The best habitat occurs in areas having water depths that allow foraging along the seafloor, and the necessary quantity and quality of sea ice and prey species for seal use. Bearded seals closely associate with sea ice, particularly when whelping and molting, and can be found in a broad range of ice types. They generally prefer ice habitat that is in constant motion and produces natural openings and areas of open water such as leads, fractures, and polynyas, for breathing, hauling out, and access to water for foraging. Heptner et al. (1976), Fedoseev (1984), Nelson, Burns, and Frost (1984), and Cameron et al. (2010) found the core distribution of bearded seals in waters less than 500 m (1,640 ft) deep. Aerts et al. (2013a) noted bearded seal densities were higher in the Burger and Statoil study areas than in the Klondike study area, which coincides with higher density and biomass of benthic prey species.

NMFS and the Marine Mammal Commission (MMC) have identified Hanna Shoal as important feeding area for bearded seals and walruses *(Odobenus rosmarus divergens)* (Marine Mammal Commission (MMC), 2013; NMFS, 2013a). Hanna Shoal is a shallow topographic feature approximately 125 km northwest of Barrow in the Chukchi Sea that sits between 15 and 40 m below the sea's surface (Smith, 2011). The Hanna Shoal region has been defined variably in different technical and scientific documents, based on different attributes such as: bathymetry, currents, sea ice dynamics, benthic productivity, animal use patterns, and other administrative considerations (78 *FR* 35363). For example, the Audubon Society (Smith, 2011) defined Hanna Shoal based on bathymetry, delineating an area of approximately 5,700 km^2 (2,200 mi^2). NMFS defines Hanna Shoal as an area of high biological productivity and a feeding area for various marine mammals, including bearded seals and ringed seals. Their maps delineate an area of approximately 7,876 km^2 (3,041 mi^2) (see Figure 3.2-26 in NMFS, 2013a for NMFS boundaries). The MMC defines the boundary of Hanna Shoal based on the 40-m isobath identified by the Audubon Society (Smith, 2011). Because of water mass movements, sea ice over Hanna Shoal persists longer than elsewhere in the Chukchi Sea, providing a refuge for ice-associated wildlife during late summer months. Bearded seals and ringed seals concentrate at Hanna Shoal from July through September (Clarke et al, 2011; Smith, 2011) and the area continues to be important foraging habitat for these species during winter months because polynya systems that can support high numbers of seals typically develop there (NMFS, 2013a). The area also supports biologically unique communities, displays moderate to high levels of benthic productivity, and is an important feeding and resting area for dermersal species (78 *FR* 35363; NMFS, 2013a).

Bearded seal diets vary with age, location, season, and changes in prey availability (Kelly, 1988). Quakenbush et al. (2011b) found bearded seals most commonly consume invertebrates, which were found in 95% of stomach samples. The majority of invertebrate prey items identified in the 2000s were mysids, isopods, amphipods, and decapods. Unlike walrus, which "root" in the soft sediment for benthic organisms, bearded seals "scan" the surface of the seafloor with their highly sensitive whiskers, burrowing only in the pursuit of prey (Marshall et al. 2006, 2008; Aerts et al., 2013a). Bearded seals switch their diet to include schooling pelagic fishes when advantageous, and fish consumption by Bering Sea and Chukchi Sea bearded seals increased between the 1970s and 2000s, but not to a statistically significant degree. Sculpin, cod, and flatfishes were the dominant fish taxa consumed by bearded seals in the 2000s (Quakenbush et al., 2011b).

The best estimate of the statewide annual ringed seal *(Phoca hispida hispida)* subsistence harvest is 6,788, and data from 2007–2009 shows an annual average of 2.70 bearded seal mortalities from commercial fishing in Alaska (Allen and Angliss, 2013). Assuming contemporary harvest levels in eastern Siberia are similar to those in Alaska, as was the pattern in the 1970s and 1980s, and a comparable struck-loss (killed but not recovered) rate of 25-50%, the total annual take from the entire Bering and Chukchi Seas would range from 16,970 to 20,364 bearded seals (Cameron et al., 2010).

Ribbon Seal

Burns (1981) estimated the global population of ribbon seals *(Histriophoca fasciata)* to be around 240,000, with 90,000-100,000 in the Bering Sea. More recent surveys have produced different numbers for this species for the areas surveyed; however, no reliable population estimates for the stock presently exists in the absence of any reliable abundance estimates (Allen and Angliss, 2014; Nelson, 2008). The existing information is sufficient to support a reasonable assessment of potential effects.

Ribbon seals inhabit the North Pacific Ocean, specifically the Bering and Okhotsk Seas, and parts of the Arctic Ocean, including the Chukchi, eastern Siberian, and western Beaufort Seas. They are strongly associated with sea ice for mating, whelping pups and molting from mid-March through June (NOAA, 2014d). However, present marine mammal monitoring from recent oil and gas activities in the Chukchi Sea (Funk et al., 2008; Blees et al., 2010; Brueggeman et al., 1992, 2009, 2010) indicates that very few ribbon seals should occur in the Leased Area.

Ribbon seals consume about 20 pounds (9 kg) of food each day, mainly feeding on pelagic fish and invertebrates, such as shrimp, crabs, squid, octopus, cod, sculpin, arctic and saffron cod, walleye pollack, eelpout, and capelin, Greenland halibut, pricklebacks, herring and sandlances, while juveniles mostly feed on krill and shrimp (Nelson 2008; NOAA, 2014d). They live for around 20 years and reach average mature weights of around 175 lbs (80 kg.) (NOAA, 2014d). Subsistence hunters in Alaska take less than 200 ribbon seals annually; this is far fewer than any other ice seal species, in part because ribbon seal distribution in open water and in the front of the sea ice usually makes them unavailable to subsistence hunters (Nelson 2008).

Ringed Seal

Few, if any, ringed seals inhabit ice-covered waters shallower than 3 m (9.8 ft) due to water freezing to the bottom and/or poor prey availability caused by the limited amount of ice-free water (71 *FR* 9782: February 27, 2006, pages 9784-9785).

Bengtson et al. (2005) conducted ringed seal surveys in the Chukchi Sea, producing estimates of 252,488 seals ±47,204 seals in 1999, and 208,857 ±25,502 seals in 2000. These were minimum population estimates for the U.S. Chukchi Sea, and fall short of the western Arctic ringed seals total population size since the estimates do not include data from the stock's remaining geographic range. Kelly et al. (2010) estimated the Arctic ringed seal population to number over 1,000,000. However, the estimate for the U.S. Beaufort Sea has not been corrected for the number of ringed seals not hauled out at the time of the surveys (Allen and Angliss, 2013).

Aerts et al. (2013a) analyzed the distribution of marine mammals in the Leased Area using data collected in 2008-2010. The study found the distribution of seal species was due to food availability. Ringed seal density reflected a slight preference for the Klondike and Statoil survey areas which have a stronger pelagic component than the Burger area. Quakenbush et al. (2011a) reported evidence that in general, the diet of Alaska ringed seals sampled consisted of cod, amphipods, and shrimp. Fish were consumed more frequently in the 2000s than in the 1960s and 1970s, and Arctic cod, saffron cod, sculpin, rainbow smelt, and walleye pollock were identified as the dominant fish, and mysids, amphipods, and shrimp, as the dominant invertebrate species in ringed seal diets. Though Arctic cod were ubiquitous throughout the Leased Area, the Klondike study area showed the highest densities of

Arctic cod (Norcross et al., 2013). Arctic cod was the main food source for ringed seals in fall and winter. During spring and summer, ringed seals had a tendency to prefer crustaceans (Aerts et al. 2013a).

Aerts et al. (2013a) noted ringed seals spend 90% of their time foraging in the water during the open-water season. Due to highly flexible diet habits and high prey mobility, they lack a clear distribution pattern. Harwood et al. (2012) tracked ringed seal migrations from the eastern Beaufort Sea to the Bering Sea, and found that ringed seals made a rapid, synchronized, westward migration into the Chukchi Sea using the same migration corridor and route that bowhead whales used.

On December 28, 2012, NMFS listed the Arctic ringed seals as threatened under the ESA (77 *FR* 76706, December 28, 2012). The best estimate of the statewide annual ringed seal subsistence harvest is 9,567, and data from 2002–2006 shows an annual average of 1.75 mortalities of Arctic ringed seals from commercial fishing operations in Alaska. Presently, polar bear predation is the largest source of ringed seal mortality, and subsistence hunting is the largest source of anthropogenic ringed seal mortality; other sources, such as entanglements and commercial fishing are very low (Allen and Angliss, 2013).

Spotted Seal

Allen and Angliss (2013) cited a spotted seal *(Phoca largha)* population estimate of 141,479 for the Alaska Stock, citing Ver Hoef et al. (in review). The lower and upper limits for the Ver Hoef et al. (in review) estimate were 92,769-321,882 individuals; however, Allen and Angliss (2013) noted no reliable minimum population estimate. The existing information is sufficient to support a reasonable assessment of potential effects.

Spotted seals make foraging trips from coastal haulouts that usually last about nine days, followed by a rest period at their haulout site, which lasts approximately two days. They have a flexible diet and are opportunistic predators, though schooling fish are their preferred prey (Aerts et al. 2013a). Data from 2008-2010 led Aerts et al. (2013b) to conclude spotted seal presence in the Chukchi Sea and in the Leased Area in particular, is dictated by food availability, which reflects the influence of oceanographic conditions.

Pacific Walrus

On February 10, 2011 (76 *FR* 7634-7679, the USFWS issued a 12-month finding on a petition to list the Pacific Walrus as Endangered or Threatened. The USFWS added the Pacific walrus to the list of candidate species and will continue to monitor the status as new information becomes available. In a court settlement with conservation organizations, the USFWS agreed to either list the Pacific walrus under the ESA, or remove them as a candidate species by 2017 (http://www.fws.gov/alaska/fisheries/mmm/walrus/pdf/factsheet_esa.pdf). The most recent estimate of the Pacific walrus population is the Speckman et al. (2011) estimate of a minimum population of 129,000 walruses, with a range of 55,000-550,000 (Speckman et al., 2011). From 2006-2010 (the most recent years for which data are available) USFWS calculated a five-year average of 1,782 walruses taken per year by Alaska Native subsistence hunters (USFWS, 2014e).

Aerts et al. (2010, 2013b) found walrus occurred in higher numbers in the Burger and Statoil study areas than in the Klondike study area. Jay, Fischbach, and Kochnev (2012) reported that satellite tagged Pacific walruses made foraging trips from ice or land haulouts that could cover several days. Aerial Surveys of Arctic Marine Mammals (ASAMM) walrus sightings from 2013 indicate most Pacific walruses use areas of the Chukchi Sea north of Point Lay once the sea ice has retreated northward of this area. As sea-ice cover retreats north off of the continental shelf, they aggregate near certain coastal areas, particularly near Icy Cape and Kasegaluk Lagoon (Clarke et al., 2014). These observations are supported by 2012 observations of Delarue et al. (2012, 2013). Delarue et al. (2012) also found walruses present in waters near Wainwright, Alaska in 2009. Collectively, the surveys indicate the preference and presence of walruses for the northern Chukchi Sea, particularly in the Hanna Shoal Area, likely due to food availability and proximity to resting habitat.

Pacific walrus spend the winters in the Bering Sea and move into the Chukchi Sea in spring as the marginal ice edge retreats northward in June-July. Walrus remain in the Chukchi Sea until late fall when they move back into the Bering Sea as the sea ice advances in October-November. As long as sea ice remains in the area, walrus concentrate over Hanna Shoal. In recent years, walrus have formed terrestrial haulouts sometimes numbering in the tens of thousands near Point Lay. Walrus must rest on sea ice, or if sea ice is unavailable, onshore between foraging bouts.

On June 12, 2013, the USFWS published new Incidental Take Regulations (ITRs) for the Oil and Gas Industry for polar bear and walrus in the Chukchi Sea for the period of 2013-2018. The USFWS specifically identified an area surrounding Hanna Shoal, referred to as the Hanna Shoal Walrus Use Area (HSWUA), as being of particular importance for foraging walrus during the summer and fall seasons (June through September) based upon recent tagging work and changes in habitat use (Jay, Fischbach, and Kochnev, 2012). The HSWUA was delineated using walrus foraging and occupancy utilization distributions (UDs) from Jay, Fischbach, and Kochnev (2012) for the months of June through September. Jay, Fischbach, and Kochnev (2012) used walrus satellite telemetry from the Chukchi Sea to delineate UDs of walrus foraging and occupancy during summer and fall from 2008 to 2011. These UDs represent the probability of animals using an area during the time specified. Utilization distributions are a commonly accepted way to delineate areas of concentrated use by a species and the 50 percent UD is often identified as the core use area or area of most concentrated use in many habitat use studies (Samuel et al., 1985; Powell, 2000; Laver and Kelley, 2008). The USFWS considers the combined 50 percent foraging and occupancy UDs from Jay, Fischbach, and Kochnev (2012) at Hanna Shoal from June to September to represent the core use area during the time of most concentrated use by walruses, and, therefore, the most appropriate way to delineate the Hanna Shoal region as it pertains to walruses.

To delineate the HSWUA, the USFWS overlaid the 50 percent UDs for both foraging and occupancy in Jay, Fischbach, and Kochnev (2012) in the Hanna Shoal area, as defined bathymetrically by Smith (2011), for the months of June through September. The combined area of those 50 percent UDs produced two adjacent polygons, one on the north slope of the bathymetrically defined shoal and one on the south slope of the bathymetrically defined shoal. Because animals using the areas delineated by those two polygons would be frequently crossing back and forth between those areas the USFWS joined the two polygons at the closest point on the west and east ends. The final HSWUA totals approximately 24,600 km^2 (9,500 mi^2) (Figure 3 in 78 *FR* 35424).

The NMFS and the MMC also identify Hanna Shoal as important walrus foraging habitat, however, the NMFS' and MMC's delineations differ both from each other and from the HSWUA. The NMFS defines Hanna Shoal as an area of high biological productivity and a feeding area for multiple species of marine mammals, including bearded seals and ringed seals. Their maps delineate an area of approximately 7,876 km^2 (3,041 mi^2) (NMFS, 2013a; see Figure 3.2-26 in NMFS, 2013a for NMFS boundaries). The MMC defines the boundary of Hanna Shoal based on the 40-m isobath identified by the Audubon Society (Smith, 2011). The HSWUA encompasses most of Hanna Shoal as delineated by the NMFS and by the MMC. A portion of Hanna Shoal as defined by the NMFS as well as by the MMC extends northwest beyond the boundary of the HSWUA. This additional area falls within the 40-m isobath but outside of the 50 UDs that the USFWS delineated for walrus and encompasses the leased blocks in the Lease Sale 193 Program that occur northward of latitude 72°N.

Polar Bear

On May 15, 2008, the USFWS listed the polar bear *(Ursus maritimus)* as threatened throughout its range (73 *FR* 28212). The most recent estimate of the Chukchi/Bering Seas (CBS) population of polar bears is 2,000 bears (Lunn et al., 2002). This figure is based on older den survey data from Wrangel

Island, rather than range-wide mark/recapture or other population survey methods; it has wide confidence intervals and is not sufficient to evaluate status or trends. The most recent estimate for the Southern Beaufort Sea population of polar bears is 900 (90% C.I. 606−1,212; C.V. = 0.106) (Bromaghin et al., In press), which is based on open population capture-recapture data collected from 2001 to 2006. The polar bear was listed as threatened throughout its range largely due to the continuing loss of sea ice habitat caused by climate change (73 *FR* 28212, May 15, 2008). Currently, the International Union for Conservation of Natural Resources, Species Survival Commission, Polar Bear Specialist Group (PBSG) lists the CBS subpopulation as declining based on reported high levels of illegal killing in Russia, continued legal harvest in the United States, and observed and projected losses in sea-ice habitat (USFWS, 2012). The Southern Beaufort Sea stock experienced little or no growth during the 1990s (Amstrup, McDonald, and Stirling, 2001). Declining survival, recruitment, and body size (Regehr, Amstrup, and Stirling, 2006, Regehr et al. 2007), and low growth rates during years of reduced sea ice during the summer and fall (2004 and 2005), and an overall declining growth rate of 3% per year from 2001-2005 (Hunter et al., 2007) indicates that the Southern Beaufort Sea population is now declining. With a small population 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, polar bear habitat in Alaska will decline by 60-80% by the end of the 21st century (Durner et al., 2007).

Polar bears remain in the consolidated pack ice of the Chukchi Sea as long as sea ice remains available, and move through the Leased Area in search of prey. The highest concentration of polar bears near the Leased Area occurs on land during the open water period, when some polar bears enter the coastal environment as they abandon melting sea ice to search for food on/near land (e.g., whale carcasses), or search for suitable den sites (pregnant females). The CBS population occurs mainly on Wrangel and Herald Islands and along the Chukotka coast, while the SBS population occurs more commonly along the coast and barrier islands of the Beaufort Sea. CBS bears spend most of the year along the consolidated pack ice edge hunting for marine mammals, primarily seals and walrus. When the sea ice retreats off of the continental shelf, some bears remain with the sea ice while others move ashore. CBS bears onshore are found primarily along the Chukotka coastline or on Wrangel and Herald Islands. On October 29, 2009, USFWS published a proposed rule in the *Federal Register* identifying proposed Critical Habitat for the Polar Bear (74 *FR* 56058). On December 7, 2010, USFWS published the final rule designating Critical Habitat in the *Federal Register* (75 *FR* 76086). The final rule identified geographic areas containing features considered essential for the conservation of the polar bear. On January 10, 2013, the U.S. District Court for the District of Alaska issued an order vacating and remanding to the USFWS the December 7, 2010, Final Rule designating critical habitat for the polar bear. Consequently, no critical habitat is designated for polar bears.

3.2.5. Terrestrial Mammals

The information that follows is in addition to the full descriptions of these species that are provided in the 2007 FEIS (Chapter III) and the 2011 SEIS (Chapter III).

Caribou

Caribou *(Rangifer tarandus)* on the North Slope include elements of the Western Arctic Caribou Herd (WAH), the Central Arctic Caribou Herd (CAH), and the more sedentary Teshekpuk Lake Caribou Herd (TCH). The WAH has declined by 4-6% annually between 2003 and 2013. An areawide survey of caribou herds conducted by the Alaska Department of Fish and Game (ADF&G) in 2013 counted 235,000 caribou in the WAH, a decline of around 27% since the time of the last estimate (325,000) conducted in 2011 (ADF&G, 2014b; Parrett, Dau, and Nedwick, 2014; Dau, 2011). Likewise the TCH and CAH populations changed from 2011 estimates of 55,000 and 67,000, respectively (Parrett, 2011; Lenart, 2011), to 32,000 (42% decline) and 70,000 (1.5% increase) (Parrett, Dau, and Nedwick, 2014). Reasons for the population declines remain under investigation by ADF&G.

Caribou are subject to mosquito harassment from mid- June into August, and oestrid fly harassment from mid-July to late-August. To escape biting insects, caribou usually move from inland feeding areas to windswept, vegetation-free upland and coastal areas, such as sandbars, spits, river deltas, and barrier islands for relief from insect pests (USDOI, MMS, 1987). Caribou encountered on barrier islands should occur in small groups numbering 20 animals or less. The primary coastal insect relief areas for WAH caribou occur between Kivalina Lagoon and Point Lay, while the TCH uses coastal insect relief areas between Barrow and the Colville River, and the CAH periodically uses coastal insect relief areas between the Colville River and western Camden Bay (NOAA, 2003, 2005).

Muskoxen occur in riparian areas and along the Beaufort Sea coast, grazing in meadows, and occasionally on gravel bars and islands in the Colville River drainage. Herd sizes are small, consisting of a few calves mixed in with adults and yearlings. Muskox herds are sedentary, usually remaining within a limited geographical area, although young males and sometimes females wander great distances. Recent radio-tracking of 121 adult female muskoxen in northwestern Alaska showed females moving across large geographic areas, contrary to prior assumptions regarding muskox site fidelity (Adams, 2013). There are approximately 4,200 (Gunn et al., 2013) muskoxen in Alaska, occurring in northcentral, northeastern, and northwestern Alaska, on Nunivak and Nelson Islands, the Seward Peninsula, and the Yukon-Kuskokwim Delta. In recent years, the herds in northeastern Alaska, especially those in Arctic National Wildlife Refuge and adjoining areas, have declined, probably due to grizzly bear predation (ADF&G, 2011; Reynolds, Shideler, and Reynolds, 2002). Muskoxen were also introduced onto Wrangel Island in 1975 and now number around 900 individuals (Gunn et al., 2013; Sipko et al., 2007).

Grizzly Bears

Grizzly bears *(Ursus arctos)* occur onshore, foraging in riparian areas, river deltas, coasts, and uplands in response to food availability or other habitat needs. Grizzlies in the Arctic require very large home ranges compared to bears farther south due to the brief growing season and low productivity in the Arctic. Mowat and Heard (2006) noted grizzly bear diets eastward of Harrison Bay on the ACP show a larger fraction of meat from terrestrial sources (≥45% of diet). This indicates a greater nutritional dependence on animal matter vs. plant matter among Arctic grizzlies than is observed elsewhere; in other areas most grizzly diets contain around 80-90% plant matter and 10-20% animal matter. Such dietary characteristics among brown bears are only noted when large concentrations and numbers of herbivores are present on the landscape. Some inland waterways, such as the Colville and Sagavanirktok Rivers, support modest spawning runs of anadromous fish, and bears are assumed to exploit such resources. Consequently, streams supporting anadromous fish may become temporary concentration areas for grizzly bears. The primary concentration area for grizzly bears along the Chukchi Sea coastline occurs on the Kasegaluk Lagoon coastline north of Point Lay, Alaska (NOAA, 2005).

Arctic Fox

Arctic foxes *(Vulpes lagopus)* are ubiquitous and numerous throughout Arctic Alaska, and sometimes "island-hop" through the barrier islands of the Beaufort Sea, scavenging, raiding bird nests, and caching food for later use. Alaska Department of Fish and Game (Caikoski, 2010; Carroll, 2010) reported healthy numbers of Arctic foxes in the Alaskan Arctic, meaning Arctic fox populations in the U.S. Arctic remain self-sustaining.

3.2.6. Vegetation and Wetlands

The Scenario being evaluated in this Second SEIS includes both onshore and offshore activities. This section describes the nearshore and onshore/inland vegetative communities that could potentially be affected by the Scenario. The areas described include:

- U.S. Alaskan coast (from Kukpuk River/Point Hope to Cape Simpson/Piasuk River) that could be impacted by an oil spill (Figure 3-13)
- The area between Icy Cape and Point Belcher and extending east to Prudhoe Bay that could be impacted by construction of shore-based facilities, including an overland oil and a gas pipeline in a right-of-way 300 miles-long (483 km) that would be laid across NPR-A
- The nearshore and shoreline habitats that extend along both the Russian coast (northern shore of Wrangel Island and Chukotka Peninsula's northern shore from Pil'khikay to Chegitun and Utkan (Figure 3-14)

The ACP is a physiographic province dominated by periglacial features (thaw lakes, marshes, and polygonal patterned ground) that provide little topographic relief with very poorly drained soils, with many lakes and irregular coastline containing many small bays, lagoons, spits, beaches, and barrier islands, (USDOI, BLM, 2012; USACE, 2012a and 2012b). With the exception of thaw bulbs under larger lakes and streams, permafrost is continuous across the ACP (Jorgenson and Shur, 2007). The U.S. Fish and Wildlife Service classified all of NPR-A coast as wetlands, available on the National Wetlands Inventory website at http://www.fws.gov/wetlands/data/mapper.html.

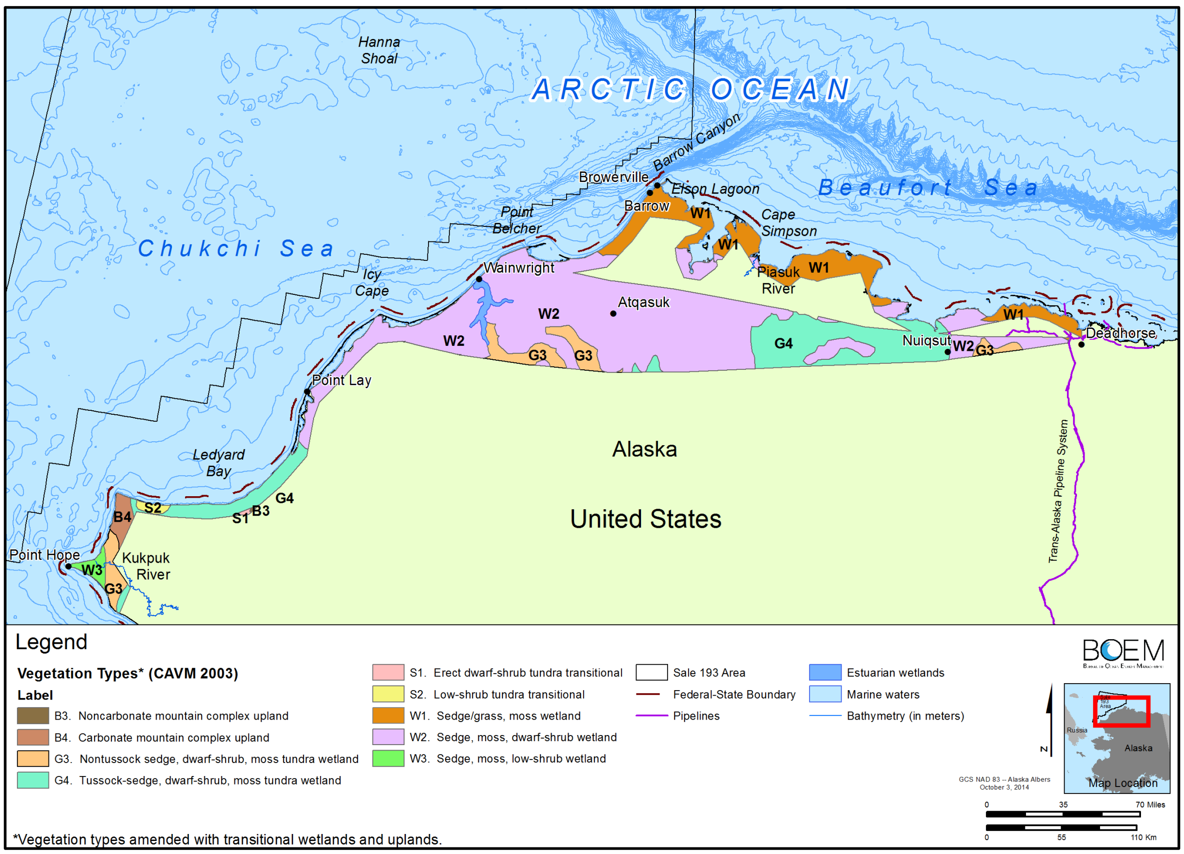

Figure 3-13. U.S. Alaska Coastal Wetland Vegetation Types and Locations. *The vegetation and wetlands are illustrated in 10 km (6.2 mi) (approximately) wide band along the coast to identify the vegetation types; though storm tides would at most carry an offshore oil spill 0.5 km (0.3 mi) inland. The illustrated wedge of vegetation and wetlands types beginning between Icy Cape and Point Belcher then narrowing to Deadhorse (Pump Station 1) would include all possible alternative alignments of the Scenario's overland pipeline right-of-way and the shore-based facilities.*

The description of vegetation in the affected area is based on studies conducted by the Circumpolar Arctic Vegetation Mapping Team (CAVMT) (Walker et al., 2003). The team worked to standardize terminology and protocols for vegetation mapping, and synthesized the information into a map for the entire Arctic region (CAVM, 2003). The CAVMT condensed over 400 plant communities from multiple sources into 15 generalized vegetation communities, the level of detail and similarities these vegetation communities by the CAVMT are useful for this analysis. The CAVM shows the types of vegetation that occur across the Arctic in Alaska and Russia, a portion of which could be affected by the Scenario.

The following descriptions, from CAVM (2003) unless otherwise noted, characterize the most common vegetation types along the coast of Russia and Alaska, as well as inland areas of Alaska that could be affected by the Scenario. In each paragraph below, the alphanumeric identifier (e.g., the W1 following "Sedge/Grass Moss Wetland" is used as both acronym and map legend locator for Figures 3-13, 3-14, and throughout the vegetation sections of this Second SEIS.

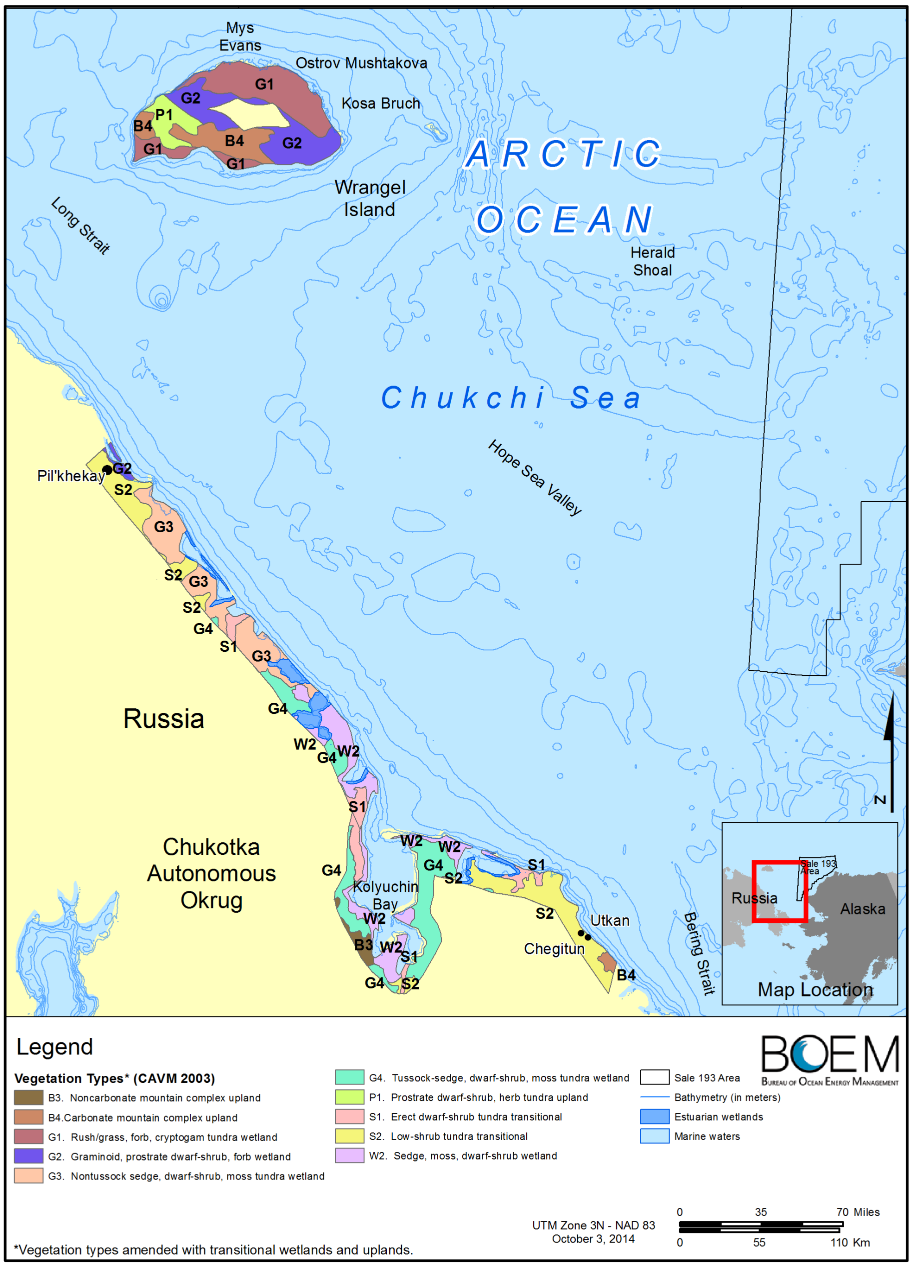

Figure 3-14. Russia Coastal Wetland Vegetation Types and Locations. *The vegetation and wetlands are illustrated 10 km (6.2 mi) (approximately) wide band along the coast to identify the vegetation types; though storm tides would at most carry an offshore oil spill 0.5 km (0.3 mi) inland.*

Sedge/Grass Moss Wetland (W1). This wetland complex is found in the colder areas of the Arctic, and dominated by sedges, grasses, and mosses. They are established in standing water, low wet areas, and moist elevated microsites, and characterized by the dominance of sedges, grasses, mosses, and forbs. Grasses are more important in colder wetlands, and elevated microsites have moist graminoid, prostrate dwarf-shrub, forb, and tundra moss species.

Sedge, Moss, Dwarf Shrub Wetland (W2). These wetland complexes are established in the milder areas of the Arctic. They are wetland dominated by sedges, grasses, and mosses, but also include dwarf shrubs <40 cm (<16 inches) tall. These wetland complexes include fens with slightly acidic to circumneutral soil pH. Large components of moist nontussock sedge, dwarf-shrub, and tundra moss are usually present in slightly elevated microsites such as hummocks and rims of low-centered ice-wedge polygons. Prostrate dwarf-shrubs and forbs are often present.

Sedge, Moss, Low Shrub Wetland (W3). This emergent wetland type is found only in the vicinity of Point Hope. These wetlands are found in warmer areas of the Arctic, and often in bog/fen complexes with deep organic soils. Large components of dwarf-shrub tundra or tussock tundra are usually present in slightly elevated microsites such as peat plateaus, and palsas, frost heave lifted soil. This wetland is dominated by sedges and low shrubs >40 cm (~16 in) tall, and wetter sites are dominated by sedges and mosses.

Rush/Grass, Forb, Cryptogam Tundra Wetland (G1). This moist tundra wetland is within the potentially affected area of Russia, and comprises a relatively large portion of Wrangell Island. This moist tundra has a moderate to complete cover of very low-growing plants, and occurs on fine-grained, often hummocky soils. Plant cover is generally moderate (40-80%) and the vegetation forms a single layer generally 5-10 cm (~2-4 in) tall. Except for the greater density of plants, particularly rushes and grasses, it is similar in composition to cryptogam, cushion-forb barrens. Grasses and rushes are usually the dominant vascular plants. Forbs are abundant. Mosses, lichens, and liverworts are common. Cryptogamic crusts composed of cyanobacteria and black crustose lichens are common. In some areas, prostrate dwarf shrubs and sedges are present but not dominant.

Graminoid, Prostrate Dwarf-Shrub, Forb Tundra (Transitional to Upland) (G2). This is a vegetation type transitional from emergent wetlands to uplands. The Russian coast has a relatively large portion, occurring on Wrangell Island and the Chukchi Peninsula coast. This vegetation type ranges from moist to dry tundra, with open to continuous plant cover, on fine-grained, often hummocky circumneutral soils with moderate snow. Tundra of this type is considered an emergent wetland where it is moist and an upland where it is dry (USACE, 2012). Plant cover is moderate (40-80%) and 5-15 cm tall. The diversity of plant communities is much greater than in Community G1 and includes snowbeds, well-developed mires, and streamside plant communities. Sedges are dominant, along with prostrate shrubs <5 cm (~2 in) tall. Sedges, rushes, and prostrate dwarf-shrubs are common. Other common plants include grasses, forbs, mosses, liverworts, and lichens.

Nontussock Sedge, Dwarf Shrub, Moss Tundra Wetland (G3). This vegetation type occurs along the Russian coast and covers a large portion of Wrangell Island. This is a moist tundra plant community established on peaty, nonacidic soils. Barren patches due to frost boils on silty soils and periglacial features are common. Plant cover is varies from 50-100%. Although vegetation is dominated by nontussock sedges and dwarf shrubs with heights generally 10-20 cm (~4-8 in), in some localized areas it reaches 40-200 cm (~16-78 in) in height, with willow thickets more than 2 m (6.6 ft) tall along steam margins. A well-developed moss layer is typical in this vegetation type. Mainly sedges prostrate and hemiprostrate dwarf shrubs, and mosses and liverworts are dominant. Other common plants include grasses, basiphilous forbs, and lichens.

Tussock Sedge, Dwarf Shrub, Moss Tundra Wetland (G4). This vegetation type abundant along both the Russian and Alaskan coasts. It is classified as moist tussock tundra and found on cold acidic soils. This vegetation community is found on unglaciated landscapes with ice-rich permafrost and shallow active layers, e.g., northern Alaska and Chukotka. Plant cover is nearly continuous (80-100%). A less robust form of tussock tundra grows in slightly warmer areas, with smaller tussock sedges and less abundant and shorter shrubs that do not overtop the tussocks. This plant community is dominated by tussock cottongrass and dwarf shrubs <40 cm (<16 inches) tall. Mosses are abundant.

Erect Dwarf Shrub Tundra (Transitional to Upland) (S1). This vegetation community is transitional from emergent wetlands to uplands. It is dominated by erect dwarf shrubs <40 cm tall (~16 in), and commonly has mosses and lichens. This vegetation type is found in acidic soils and areas adjacent to estuarine or marine waters. On dry ridges, a drier, lichen-rich dwarf-shrub tundra is commonly established. Plant cover is continuous (80-100%) on wetter sites, but sparse (5-50%) on dry ridges.

Low Shrub Tundra (Transitional to Upland) (S2). This vegetation type is transitional from emergent wetlands to uplands. It is found along both the Alaska and Russian coasts. This vegetation community is found in moist tundra with permafrost-free soils, although it is common to find it in permafrost peatlands and wet areas as well. Upland areas have mainly oligotrophic hypoarctic shrubs. Thick moss carpets are common in most shrublands. Along drainages and near treeline, low and tall willows and alders are abundant. This vegetation community type is dominated by low shrubs >40 cm (>16 in) tall sometimes on permafrost-free soils.

Carbonate Mountain Complex Upland (B4). This upland vegetation type is found along the U.S./Alaskan coast at Cape Lisburne and a small portion of Russia's Wrangel Island coast. This vegetation is established on dry, calcareous tundra complexes on mountains and plateaus with limestone and dolomite bedrock. Elevation gradients provide similar summer temperature variations to those observed in bioclimatic subzones, responding with similar vegetation physiognomy. The dominant plants are lichens species that prefer rocky surfaces with alpine sweetgrass, and other lichens species that prefer soil grow between the bedrock outcrops.

Estuarine Wetlands. Estuarine wetland systems are enclosed and protected bays, which are partly obstructed, or with sporadic access to the open ocean. Estuarine 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. The range of intertidal plants, most notably eelgrass, only extend as far north as the Seward Peninsula along the Bering Sea (Viereck et al., 1992). Non-vegetated intertidal wetlands are found along the Chukchi Sea shoreline of both Russia and the U.S./Alaska. These wetlands are classified as estuarine intertidal with unconsolidated shores, estuarine intertidal with aquatic beds, or estuarine subtidal unconsolidated bottoms (Cowardin et al., 1979). Within the area of Alaska that could be potentially affected by the Scenario, large estuarine wetland complexes are found just south of Point Hope, extending eastward along the coast to Harrison Bay in the Beaufort Sea. These wetlands are found in communities such as: Aiautuak Lagoon, Marryat Inlet, Omalik Lagoon, Kasegaluk Lagoon, Lagoons on each side of Icy Cape, Wainwright Inlet, Peard Bay, Eilson Lagoon, Admiralty Bay, Kugorak Bay, Smith Bay and Harrison Bay. Within the potentially affected area of Russia, estuarine wetlands are found in: the Laguna Tenergynpil'gyn, Laguna Nutaug, Laguna Vankarem, Laguna Pyngopil'gyn, Chukotskoe More, Laguna Neskynpil'gyn, Lagoon Inchoun and Laguna Uellen, and along the northern coast of the Kamchatka Peninsula where estuarine wetland complexes would be waterward of the vegetated wetlands. Wrangel Island also has lagoons along its north shore.

Threatened / Endangered and Sensitive Plant Species

No federally-listed threatened or endangered plants are known to occur on the ACP (USFWS, 2014d). The Alaska Natural Heritage Program (AKNHP) maintains a database of rare vascular plant species, which includes global and state species status ranks. Plants ranked as critically imperiled or imperiled in Alaska could occur in the area potentially affected by the Scenario. These include eight BLM sensitive species of plants which are known to occur (Cortés-Burns et al., 2009) within the area potentially affected by the Scenario for this SEIS:

- Alpine Whitlow-grass (*Draba micropetala*)
- Adam’s Whitlow-grass (*Draba pauciflora*)
- Oriental Junegrass (*Koeleria asiatica*)
- Drummond’s bluebell (*Mertensia drummondii*)
- Arctic poppy (*Papaver gorodkovii*)
- Sabine grass (*Pleuropogon sabinei*)
- Alaskan bluegrass (*Poa hartzii ssp. Alaskana*)
- Circumpolar cinquefoil (*Potentilla stipularis*)

3.3. Sociocultural Systems

3.3.1. Economy

For this analysis, economic activity in the NSB, State of Alaska, and U.S. is measured in the form of revenues, employment, and personal income.

The tax base in the NSB consists mainly of high-value property owned or leased by the oil industry in the Prudhoe Bay area. According to the Alaska Department of Commerce, Community, and Economic Development (ADCCED, 2013), NSB oil and gas property tax revenues have exceeded $180 million annually since 2000. In 2005, revenues from oil and gas property taxes were $188 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 directly employed by the oil and gas industry or supporting industries in and near Prudhoe Bay since production started in the 1970s. Local residents represent only about 1% of those hired for North Slope oil industry related jobs, with most North Slope oil-industry workers residing outside the NSB. According to the Alaska Department of Labor and Workforce Development (ADOLWD, 2014b), 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 important in the State of Alaska generally, accounting for more than 41,000 jobs, 9.4% of employment, and 11.2% of wages in the state.

According to ADCCED (2013), in 2013, NSB revenues from oil and gas property taxes were $322 million, $43,959 per capita. These figures represent a significant change from recent past years’ totals, as NSB’s revenues from oil and gas property taxes increased by $87 million since 2008.

According to the ADOLWD (2014b), average employment for the NSB in 2012 was 5,212. Unemployment in the NSB was 5% in 2013. Since 2000, unemployment in the NSB was a high of 10.1% in 2004, and a low of 4.1% in 2008. Aggregate personal income for the NSB was $491 million, and per capita personal income in 2012 was $50,918. These figures are generally consistent with aggregate personal income figures over recent past years.

Additional information and a more detailed profile of the economy of the NSB and its communities is available in USDOI, BLM (2014).

3.3.2. Subsistence-Harvest Patterns

Subsistence harvesting is practiced by Alaska Natives and rural residents alike and is generally considered to be hunting, fishing, and gathering for the primary purpose of acquiring traditional food. The MMPA of 1972, as amended, defines subsistence:

> 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 handicraft articles out of nonedible byproducts of marine mammals taken for personal and family consumption; and for barter, or sharing for personal and family consumption (16 USC 1361).

Federal law pertaining to subsistence harvesting of onshore resources in Alaska is contained in the Alaska National Interest Lands Conservation Act (ANILCA). The ANILCA framework is used as a basis for current subsistence activity on non-Federal lands as well, and is codified in the North Slope Borough Municipal Code (NSBMC) and the Northwest Arctic Borough Code (NABC) subsistence regulations.

The majority of permanent residents of the NSB and the Northwest Arctic Borough (NWAB) are Alaska Natives (Table 3-13). For these residents, many subsistence activities are a central focus of personal and group cultural identity. Subsistence harvests are usually group activities that further core values of community, kinship, cooperation, and reciprocity, not only providing cultural identity, social integration, and solidarity, but also a diet that is essential for good health and one that Alaska Natives view as healthier than packaged food diets (Nobmann et al., 2005). Subsistence harvests also provide special foods for religious and social occasions, preserving traditional practices such as the Apugauti (Beaching of the Boats) festival and the Nalukataq (Spring Whaling) festival, held to appease the spirits of the deceased whales and ensure the success of future hunting seasons (Iñupiat Heritage Center, 2014; DCRA, 2014; ASRC, 2014). The sharing, trading, and bartering of subsistence foods connects communities, and the giving of these foods to each other helps maintain ties with family members elsewhere in Alaska.

Subsistence activities practiced by the Iñupiat are further analyzed in studies which examine relationships between subsistence and wage economies, and how these traditional and modern ways of life are integrated into Alaska Native community cultural and social systems (Howe, 2014; Haley and Magdanz, 2008). Subsistence harvesting can provide a link to the market economy, with many households in NSB, NWAB, and other regional communities earning cash from crafting whale baleen and walrus ivory, and from harvesting furbearing terrestrial mammals. Studies have found Iñupiat communities which have both subsistence activities and wage earning opportunities are highly developed, and community members are highly dependent on each other in these 'mixed-economies' (Harcharek, 1995; Shepro and Maas, 1999). Individuals most active in subsistence harvests and providing for others in the community tend to be those individuals who are also involved in the wage economy (e.g., ability to purchase a boat, fuel, guns, and ammunition). Full-time employment limits the time a subsistence hunter can spend hunting to after work hours and can shorten the time to gather food for the year. See Section 3.3.1 Economy for a more in-depth discussion.

3.3.2.1. Community Descriptions

This section discusses communities that may be affected by activities in the Leased Area (Figure 3-15). The discussion begins with information and demographics related to NSB communities closest to the Leased Area with a likelihood of being affected by oil and gas activities. The discussion then moves to communities farther south and west of the Leased Area in the NWAB, communities of the Bering Strait, and communities along the Russian coast located in the Chukotka Region.

Communities discussed rely on many of the same migratory species for subsistence harvesting, and it is likely these species would pass through the Leased Area at some time during their migration.

Communities closest to the Chukchi Sea Leased Area are located in the NSB and include Barrow, Wainwright, Point Hope, and Point Lay along the coast, and Atqasuk which lies inland (Table 3-13). Nuiqsut and Kaktovik, east of the Leased Area of the Beaufort Sea, are discussed due to their strong cultural ties to whaling and concerns with effects of oil and gas activities on this subsistence resource. Communities farther away from the Leased Area but considered in this analysis are located in the NWAB, Bering Strait communities, and in Far-Eastern Russia. Communities in these regions also utilize overlapping subsistence resources and hunting use areas with NSB. Communities most likely to be affected are included in the subsistence discussions in Chapters 4 and 5. Communities in the NWAB, located south of the Leased Area, include the 11 communities of Ambler, Buckland, Deering, Kiana, Kivalina, Kobuk, Kotzebue, Noatak, Noorvik, Selawik, and Shungnak. These communities are predominantly Alaska Native (Table 3-13) and are regularly involved in subsistence harvesting of marine and terrestrial resources.

Figure 3-15. Communities that May Be Affected by Leased Area Activities.

Farther south from the Leased Area are four subsistence-dependent communities that participate in the whale hunt: Diomede, Wales, Gambell, and Savoonga (Table 3-13). These communities are located on or near the Bering Strait, through which migrating whales must pass to reach their wintering locations in the Bering Sea and their summering locations in the Canadian Beaufort Sea.

Communities on the west side of the Leased Area are located in Russia, and indigenous Chukotan peoples who rely on subsistence hunting reside in the Chukchi Sea coastal areas of the Chukotsky Autonomous Okrug region. In this area, important coastal lagoons and nearshore subsistence harvest areas for gray and bowhead whales, beluga whales, other marine mammals, fish, seabirds, and other resources could be affected by activities occurring in the Leased Area. In these permanent indigenous settlements, subsistence hunting and fishing occur year round.

Communities adjoining the Chukchi Sea, located closest to the Leased Area, utilize a diverse subsistence harvest resource base along with other Alaska Native communities and several Russian communities. Shared resources include coastal/marine food resources (whales, seals, walrus, waterfowl, fish, and shellfish), and terrestrial/onshore resources (caribou, moose, bears, other terrestrial mammals, furbearing animals, edible roots, plants, and berries). Community profiles include updated information from regional and village Native Corporations, the 2010 U.S. Census and the Alaska Department of Fish and Game subsistence data.

Table 3-13. Information and Population Demographics of Alaska Native Communities.

Communities	Population	Percent Alaska Native
North Slope Borough Communities		
Barrow	4,717	63
Wainwright	543	90
Point Lay	215	88
Point Hope	683	90
Atqasuk	248	92
Nuiqsut	452	87
Kaktovik	262	89
Northwest Arctic Borough		
Ambler	264	85
Buckland	487	95
Deering	139	87
Kiana	406	90
Kivalina	402	96
Kobuk	159	89
Kotzebue	3,202	75
Noatak	562	95
Noorvik	641	89
Selawik	872	86
Shungnak		
Bering Strait Communities		
Wales	150	86
Diomede	119	92
Gambell	722	96
Savoonga	718	95
Shishmaref	589	94

Sources: Norris, Vines, and Hoeffel, 2012; DCRA, 2014; ASRC, 2014; Russian Federation, 2014.

North Slope Borough Communities

The North Slope Borough encompasses 89,000 mi^2 (230,508 km^2) of tundra and upland areas. Its boundaries range from the northern extent of the Brooks Range to the Chukchi Sea to the Canadian border on the east. The region is home to a predominantly Iñupiaq Eskimo population that inhabit the Borough's eight communities. NSB communities discussed below are the coastal community of Barrow, located at the confluence of the Beaufort and Chukchi Seas; Wainwright, located southwest of Barrow on the Chukchi Sea; Point Lay, Point Hope, and the inland community of Atqasuk. These shoreline communities are located more than 60 miles from the Leased Area (Figure 3-15) but have the potential to be the first communities affected by oil and gas activities which might occur in the Leased Area. The NSB communities that share resources migrating through the Leased Area are Nuiqsut, near the Colville River Delta, and Kaktovik, near the Canadian border. Atqasuk, the only inland community, is discussed here because its subsistence resources could be affected by activities related to an onshore pipeline from the Chukchi Sea Leased Area, through the NPR-A, and ending at the Trans-Alaska Pipeline System (TAPS). Subsistence community descriptions for Nuiqsut and Kaktovik are discussed in brief at the end of this section because they use migratory species such as bowhead whales for subsistence, and the chance of effects in the migration pathways from development and potential oil-spill contacts is possible outside of their hunting areas.

Barrow is the largest permanent community on the North Slope and serves as the administrative and commercial hub of the region. It is a traditional Iñupiaq settlement and the area's largest employer, with numerous businesses providing support services to oil field operations. During the summer months, tour operators offer package tours of Barrow and the surrounding area. Barrow is served by passenger air service and freight arrives by barge in the summer and by air cargo year-round. The population of Barrow is 4,717 and 63% are Alaska Native. Subsistence whaling, hunting, and fishing are important to the economy, and many residents with full- or part-time employment continue to hunt and fish for food (DCRA, 2014; City of Barrow, 2014). Braund (2010) identifies the subsistence harvest resources in Barrow in the 12 months after 2006 to be bowhead whale, ringed and bearded seal, walrus, fish, birds, caribou, and other terrestrial mammals.

Wainwright is located on the coast 137 km (85 mi) southwest of Barrow. Transportation to Wainwright is available by air service from Barrow and Anchorage, and freight arrives by cargo plane and barge. Although the population of Wainwright is 543 and 90% are Alaska Native, the economy is mixed cash subsistence, and the Wainwright ANCSA Village Corporation, Oolgoonik, constructed a facility in the community for fly-in-fly-out workers, the revenues of which are presumably distributed to shareholders for economic gain. The population is highly dependent on subsistence hunting (DCRA, 2014; Norris, Vines, and Hoeffel, 2012). In 2012, the main subsistence resources harvested were bearded seals and bowhead whales. Other resources harvested in 2012 were spotted and ringed seals, walrus, fish, waterfowl, shorebird eggs, caribou, and brown bear (Braund, 2013).

Point Lay is located about 153 km (95 mi) farther down the coast, and is another traditional Iñupiaq community heavily dependent on subsistence harvesting. Passenger service to Point Lay is available by airline flights and charters from Barrow and Anchorage. Freight is delivered by air and barge. The population of Point Lay is 215 with approximately 88% being Alaska Native. Situated near the Kasugaluk Lagoon, it is a prime location for hunting beluga whales, but residents also participate in the bowhead whale hunt (DCRA, 2014; ASRC, 2014). Braund (2013) states that in 2012, Point Lay harvested not only beluga and bowhead whales, but also bearded, ringed, and spotted seal, walrus, fish, waterfowl, shorebird eggs, caribou, and berries.

Point Hope is located south of Cape Lisburn about 193 km (120 mi) to the southwest of Point Lay and is one of the longest continuously occupied Iñupiaq areas in Alaska. The peninsula offers good access to marine mammals, and typical ice conditions allow easy boat launchings into open leads early in the spring whaling season. Most full-time employment is with North Slope Borough and city governments. The population of Point Hope is 683 and 90% are Alaska Native (DCRA, 2014; Norris, Vines, and Hoeffel, 2012). The community has retained a strong traditional culture and is also the site of Nalukataqs (Whaling Festivals) to celebrate successful whale hunts (DCRA, 2014; ASRC, 2014). Subsistence activities in Point Hope are practiced throughout the year and revolve around harvesting bowhead and beluga whales, other marine mammals, polar bears, fish, birds, caribou, other terrestrial mammals, and berries.

Atqasuk is an inland community located on the Meade River about 100 km (62 mi) east of Wainwright and 97 km (60 mi) south of Barrow. Air service from Barrow provides passenger and cargo service to Atqasuk. The population of Atqasuk is 248 and 92% are Alaska Native (DCRA, 2014; Norris, Vines, and Hoeffel, 2012). Located well inland, it is connected to the Beaufort Sea by the Meade River, and its inhabitants participate in marine subsistence harvests. Subsistence resources used by Atqasuk residents are acquired on coastal hunting trips in Barrow or Wainwright with relatives or friends, and the local connection with the coast and marine resources is important to the community. One resident has been quoted as saying: "We use the ocean all the time, even up here; the fish come from the ocean; the whitefish as well as the salmon migrate up here" (ACI, Courtnage, and Braund, 1984). Atqasuk hunters harvest the community's key resources of migratory waterfowl, fish, caribou, moose, and berries. Harvest use areas used exclusively by the community are the entire Meade River drainage, the Avalik River, the upper Okpiksak, the Topagoruk, and the Nigisaktuvik rivers (SRB&A and ISER, 1993).

Nuiqsut is located about 29 km (18 mi) south of the Colville River headwaters at the Beaufort Sea and 219 km (136 mi) southeast of Barrow. It is located in the midst of many oil company facilities in the region. Alpine oil field, which began operations in 2000, is located approximately 13 km (8 mi) north of Nuiqsut (Braund, 2010). In 1973, 27 Iñupiat families moved back to Nuiqsut from Barrow; in 1974, the Arctic Slope Regional Corporation funded construction of the community. Air travel provides the only year-round access, and snowmachines are used for local transportation. The population of Nuiqsut is 452 and 87% are Alaska Native (DCRA, 2014; Norris, Vines, and Hoeffel, 2012). The Colville River Delta has traditionally been a gathering and trading place for the Iñupiat, and a good source of resources for subsistence hunting and fishing. Nuiqsut's economy is based primarily on subsistence hunting, fishing, and whaling. Nuiqsut harvests subsistence resources offshore, nearshore, and onshore. Cross Island, due to being the primary whale hunting location and housing permanent camps, is an area of great importance when harvesting bowhead whales (Galginaitis, 2013). Nuiqsut residents hunt bowhead in September, but have also hunted as early as August and as late as October. Nuiqsut residents also harvest seal, fish, birds, eggs, caribou, moose, other terrestrial mammals, and berries.

Kaktovik, including Barter Island, is located 145 km (90 mi) west of the Canadian border and 451 km (280 mi) southeast of Barrow. The community is on the northern edge of the 20-million-acre (8.1 million hectare (ha)) Arctic National Wildlife Refuge. There are 262 residents and 89% are Alaska Native (DCRA, 2014; Norris, Vines, and Hoeffel, 2012). Like other communities in the region, subsistence hunting, fishing, and whaling play a major role in the local economy, and are a vital part of life for the people of Kaktovik. Marine mammals hunted are seal, walrus, and whales. The people of Kaktovik practice shore-based whaling for bowhead whales in the fall as opposed to the spring. Terrestrial animals hunted include muskoxen, caribou, and sheep. Subsistence harvests include hunting in the nearby area for Dall sheep, moose, caribou and fox. The community also produces arts and crafts for sale, such as etched baleen, carved ivory and masks.

Northwest Arctic Borough Communities

The Northwest Arctic Borough is the second largest borough in Alaska, slightly bigger than the state of Indiana, and comprised of approximately 39,000 mi^2 (101,009 km^2) (35,898.3 mi^2 (92,975 km^2) of land and 4,863.7 mi^2 (12,595 km^2) of water). Its coastline is limited by the Chukchi Sea and Kotzebue Sound, an important wildlife area and prominent water body. The region is home to a predominantly Iñupiaq Eskimo population that inhabit the Borough's eleven communities. These communities are located away from the Leased Area, but the subsistence resources they rely on could be affected by oil and gas activities in the Leased Area. They are discussed below due to their sharing of subsistence resources which would have a high probability of passing through the Leased Area during migration.

Ambler is located on the north bank of the Kobuk River, near the confluence of the Ambler and Kobuk Rivers. It is located 222 km (138 mi) northeast of Kotzebue; 48 km (30 mi) northwest of Kobuk, and 48 km (30 mi) downriver from Shungnak. Ambler's major means of transportation are planes, small boats, and snowmachines. There are no roads linking the community to other parts of the state. Boats are used for inter-community travel and subsistence activities, while ATVs and snowmachines are commonly used in winter. The population of Ambler is 264 and 95% of the community are Alaska Native (DCRA, 2014; Norris, Vines, and Hoeffel, 2012). The residents are mostly Kowagniut Iñupiat Eskimos, who lead a traditional subsistence way of life dependent on chum salmon, freshwater fish, caribou, moose, bear, and berries.

Buckland is located on the west bank of the Buckland River, about 121 km (75 mi) southeast of Kotzebue. Buckland's primary means of transportation are plane, small boat, barge, and snowmachine, since there are no roads outside of the community. Boats are used for travel to other communities and for subsistence activities. The population of Buckland is 487 and 95% are Alaska Native (DCRA, 2014; Norris, Vines, and Hoeffel, 2012). Subsistence activities are an important component of the way of life, as residents depend on caribou, beluga whale, and seal for survival.

Deering is located on the Kotzebue Sound at the mouth of the Inmachuk River, 92 km (57 mi) southwest of Kotzebue. It lies on a flat gravel spit 300 ft wide (91.4 m) and a 0.5 mi long (0.8 km). Deering is accessible year-round by plane. Small boats, ATVs and snowmachines are used for local travel, and winter trails are available to Buckland. The population of the community is 139 with 87% Alaska Native (DCRA, 2014; Norris, Vines, and Hoeffel, 2012). For subsistence, residents rely heavily on beluga whale, seal, fish, birds, moose, and rabbit.

Kiana is located at the junction of the Kobuk and Squirrel Rivers, 57 miles (92 km) east of Kotzebue. Kiana is a traditional Iñupiat Eskimo community dependent on a subsistence way of life. The major means of transportation are plane, small boat, and snowmachine. Boats, ATVs and snowmachines are used extensively for local travel and a road extends along the river for several miles along with a network of old trading trails in the area. In winter, a road is usually plowed over the frozen Kobuk River from Kotzebue to Noorvik, then on to Kiana. The population of the community is 406 with 90% Alaska Native (DCRA, 2014; Norris, Vines, and Hoeffel, 2012). Subsistence resources include chum salmon, freshwater fish, waterfowl, caribou, moose, and berries.

Kivalina is at the tip of an 8 mi (13 km)-barrier island located between the Chukchi Sea and Kivalina River. It lies 129 km (80 mi) northwest of Kotzebue. Kivalina is a traditional Iñupiat Eskimo community and subsistence activities, including whaling, provide most of the food. The major means of transportation into the community are airplanes and small boats, and the Chukchi Sea is usually ice-free and open to boat traffic from July 1 to the first of November. Small boats, ATVs and snowmachines are used for local travel, but there are no roads that meet outer highways or any other communities. However, there are several trails that follow nearby rivers, as well as marked snowmachine trails that connect to other communities, including Kotzebue. The population is currently about 402 with 96% Alaska Native (DCRA, 2014; Norris, Vines, and Hoeffel, 2012). Kivalina has long been a stopping-off point for seasonal travelers between arctic coastal areas and Kotzebue Sound communities. Due to severe erosion, the community has been planning to relocate to a new site 7.5 miles (12 km) away. Kivalina's economy is based primarily on yearly subsistence harvest of whale, seal, fish, and caribou.

Kobuk is located on the right bank of the Kobuk River, 206 km (128 mi) northeast of Kotzebue. Founded in 1899 as a supply point for mining activities in the Cosmos Hills to the north, Kobuk is the smallest and most remote community in the Northwest Arctic Borough. Kobuk's major means of transportation are barge, plane, small boat, and snowmachine. Boats, ATVs, and snowmachines are used for local travel along several trails following the river for year-round inter- community travel and subsistence activities. There is also a 11 km (7 mi) ice road to Shungnak during the winter. The population is currently about 159 with 89% Alaska Native (DCRA, 2014; Norris, Vines, and Hoeffel, 2012). Kobuk, an Iñupiat Eskimo community, practices a traditional subsistence way of life and the economy of Kobuk is closely tied to subsistence. Kobuk is dependent on fish, caribou, and moose taken during subsistence harvests.

Kotzebue is located on a 3 mi-long (4.8 km) spit ranging in width from 1,100 to 3,600 feet (335-1,097 m), located on the Baldwin Peninsula near the discharges of the Kobuk and Noatak Rivers. Due to its location at the confluence of three river drainages, Kotzebue is the transfer point between ocean and inland water shipping and also the air transport center for the region. It is 428 km (266 mi) south of Wainwright and 42 km (26 mi) above the Arctic Circle, and is the service and transportation center for the eleven communities in the Northwest Arctic Borough. The site of Kotzebue, or Qikiktagruk (as it is called in Iñupiaq), has been occupied by Iñupiat Eskimos for at least 9,000 years, and is believed to be the oldest settlement in both North and South America. Air is the primary means of transportation year-round, and the shipping season lasts 100 days, from early July to early October, when Kotzebue Sound is ice-free. Due to river sediments deposited by the Noatak River four miles (6.4 km) above Kotzebue, the harbor is shallow, requiring deep-draft vessels to anchor fifteen miles (24 km) out, and cargo to be lightered to shore to be warehoused. There are 42 km (26 mi) of local gravel roads, used by automobiles, ATVs, and motorcycles during the summer. Snowmachines are preferred in winter for local transportation and in winter, the Kotzebue Sound and all rivers and lakes freeze, allowing transportation via snowmachines and ATVs. The population of Kotzebue is 3,202 with 75% Alaska Native (DCRA, 2014; Norris, Vines, and Hoeffel, 2012). Subsistence activities are an integral part of the residents' way of life, and each summer they set up the North Tent City fish camp, where the season's catch is dried and smoked. As a regional economic center, Kotzebue offers a mixture of private sector business and traditional subsistence activities found nowhere else in the region. It is also a regional spot for the sale of arts and crafts. There is both commercial and subsistence fishing for salmon, sheefish, and other seafood. Subsistence harvest resources include beluga whales, seals, walrus, polar bear, fish, birds, caribou, moose, other terrestrial mammals, and berries.

Noatak is located 88 km (55 mi) north of Kotzebue and 113 km (70 mi) north of the Arctic Circle. It is located on the west bank of the Noatak River, one of the largest unspoiled rivers in the United States. Noatak is the only settlement on the 400 mi-long (644 km) Noatak River. Noatak was officially established as a fishing and hunting camp in the 19th century, but Iñupiat have inhabited the area for several hundred years. The area's rich subsistence resources enabled the camp to develop into a permanent settlement. Noatak is primarily accessed by air, and locally, small boats, ATVs, and snowmachines are used extensively for transportation. There are many historic trails along the Noatak River for inter- community travel and subsistence purposes. The current population of Noatak is 562 with 95% Alaska Native (DCRA, 2014; Norris, Vines, and Hoeffel, 2012). Subsistence activities are the central focus of the community culture and many families travel to fish camps at Sheshalik during the summer. Noatak's economy is based primarily on subsistence activities, with residents harvesting beluga whale, seal, walrus, fish, birds, caribou, moose, other terrestrial mammals, and berries.

Noorvik is located on the right (south) bank of the Nazuruk Channel of the Kobuk River 76 km (47 mi) east of Kotzebue. The community is downriver from the 1.7-million acre (688 thousand (K) ha) Kobuk Valley National Park and is one of the largest communities in the Northwest Arctic Borough. Noorvik is accessible by plane, small boats and barges. There are no roads linking the community to other areas of the state. Boats, ATVs and snowmachines are common means of transportation around the community. In the winter a road is usually plowed over the frozen Kobuk River from Kotzebue to Noorvik, then on to neighboring Kiana. The population of Noorvik is currently 641 with 89% Alaska Native (DCRA, 2014; Norris, Vines, and Hoeffel, 2012). Subsistence is an important part of Noorvik's culture and economy. Several residents commercially fish in the Kotzebue Sound and Kobuk River. Noorvik residents primarily harvest broad whitefish, rainbow smelt, birds, eggs, caribou, moose, and other terrestrial mammals.

Selawik is located at the mouth of the Selawik River, about 113 km (70 mi) southeast of Kotzebue. The community, known as Akuligaq in Iñupiaq, is near the Selawik National Wildlife Refuge, a key breeding and resting spot for migratory waterfowl. Selawik is accessible by plane and boat. The community lies on the banks of the Selawik River, with bridges which link the different sections, and boardwalks have been constructed for walking and driving around the community. Boats, ATVs, and snowmachines are the main forms of local transportation. Winter snowmachine trails connect Selawik to Kotzebue and nearby communities. The population of Selawik is 872 with 86% Alaska Native (DCRA, 2014; Norris, Vines, and Hoeffel, 2012). Selawik is active in traditional subsistence harvesting and depends on fish, birds, eggs, caribou, moose, other terrestrial mammals, and berries.

Shungnak is located on the winding shoreline of the Kobuk River about 241 km (150 mi) east of Kotzebue, and about 16 km (10 mi) downstream from the community of Kobuk. Shungnak is a traditional Iñupiat Eskimo community based on a subsistence way of life and is accessible by plane, barge or small boat in the summer and by plane and snowmobile in the winter. Small boats, ATVs, snowmachines, and dog sleds are used for local travel and subsistence activities with old trails along the river used for inter-community travel. The community has a population of 294, and 94% of which are Alaska Native (DCRA, 2014; Norris, Vines, and Hoeffel, 2012). Shungnak residents subsist mainly on fishing, hunting and trapping, and the community has an economically strong arts and crafts industry where residents sell finely crafted baskets, masks, mukluks, parkas, hats, and mittens. Subsistence resources residents rely on are fish, birds, eggs, caribou, moose, other terrestrial mammals, and berries.

Bering Strait Communities

The Bering Strait region encompasses the majority of Alaska's Seward Peninsula and the coastal lands of eastern Norton Sound. This region is perhaps the most culturally diverse area in the state with three Native languages spoken: Siberian Yup'ik, Central Yup'ik, and Iñupiaq. For centuries, the land has provided a subsistence way of life for residents of the Bering Strait, Seward Peninsula, and Norton Sound region which continues to be a central activity for residents today. The Bering Strait, where communities discussed are located, is the westernmost point of the North American continent and is 82 km (51 mi) wide at its narrowest point, between Cape Dezhnev, Chukchi Peninsula, Russia and Cape Prince of Wales, Alaska. The Bering Strait Region has been the subject of scientific speculation that humans migrated from Asia to North America across a land bridge located in this region known as Beringia (Beck et al., 1999). Communities discussed here are located away from the Leased Area but subsistence resources they rely on have a chance to be affected by oil and gas activities which would occur in the Leased Area. Further, much of the vessel traffic and other resources used in conducting Leased Area activities may pass through this region.

Wales is one of the oldest communities in the Bering Strait region. The Iñupiat language name for Wales is Kiñigin, named for the mountain that rises above it. The people of Wales refer to themselves as Kigiataanaimiut, "the people of Kiñigin." In April, 1964, the community organized as a municipality under the State of Alaska. One reason for the community's success was its exceptional access to marine mammals. The narrowing of the Bering Strait at Cape Prince of Wales concentrates migrations of bowhead whale, seal, walrus and salmon. The population of Wales is 150 with 86% Alaska Native (DCRA, 2014; Norris, Vines, and Hoeffel, 2012). Subsistence resources harvested in this community are walrus, bearded and other seals, bowhead and beluga whales, fish, marine invertebrates, birds, eggs, terrestrial mammals, plants and berries (Magdanz, Utermohle, and Wolfe, 2002).

Diomede is located on the west coast of Little Diomede Island in the Bering Strait, 217 km (135 mi) northwest of Nome. It is only 4 km (2.5 mi) from Big Diomede Island, Russia, and the international boundary lies between the two islands. Early Iñupiat residents of the islands worked on the ice and sea, and had a culture with elaborate whale hunting ceremonies and traded with both continents. The 1880 Census counted 40 people, all Ingalikmiut Eskimos, in the community of "Inalet." Residents have pursued relocating the community, due to the rocky slopes, harsh storms, lack of useable land for housing construction, and inability to construct infrastructure. Transportation to Diomede by air is limited to helicopter during the summer months (plane access is not possible because of steep slopes and rocky terrain), while in the winter it is possible to land planes on the sea ice. Boat travel over the 28 miles (45 km) to Wales occurs periodically, sometimes by skin or aluminum boats, and can be very dangerous due to rapidly changing weather conditions and strong currents. The population of Diomede is 119 with 92% Alaska Native (DCRA, 2014; Norris, Vines, and Hoeffel, 2012). As a traditional Ingalikmiut Eskimo community, a subsistence way of life is of great importance, and Diomede is almost entirely dependent on subsistence hunting in marine waters and on the mainland, but is also a center of trade in walrus ivory (DCRA, 2014; Braund and Langdon, 2011). The subsistence resources utilized for Diomede are bowhead and beluga whale, seal, walrus, fish, crab, and polar bear. The people of Diomede hunt whales during the spring from open leads in the sea ice. Alaska Natives come from inland to Diomede to hunt polar bears. Economically, Diomede utilizes seal and walrus hides to make parkas, hats, mukluks, furs, and skins for trade.

Gambell is located on the northwest cape of St. Lawrence Island (which is privately owned by the ANCSA corporations), 322 km (200 mi) southwest of Nome, in the Bering Sea. The city is 58 km (36 mi) from the Chukotka Peninsula, Siberia. St. Lawrence Island has been inhabited intermittently for the past 2,000 years by Yup'ik Eskimos. In the 18th and 19th centuries, over 4,000 people inhabited the island in 35 communities. In 1900, reindeer were introduced to the island for local use, and in 1903 a reindeer reservation was established. The isolation of Gambell has helped residents to maintain their traditional St. Lawrence Yup'ik culture, their language, and their subsistence way of life, which is based heavily on marine mammals. Gambell's isolated location on an island with no seaport results in heavy dependence upon air transport. Regular flights from Nome and charters from Unalakleet are available for residents and non-residents who wish to travel there. The population of Gambell is 722 with 96% Alaska Native (DCRA, 2014; Norris, Vines, and Hoeffel, 2012). In Gambell, 80% of the diet comes from subsistence resources and is based on harvesting walrus, bearded and other seals, whales, fish, birds, eggs, terrestrial mammals, plants and berries. Some reindeer roam free on the island, but most harvesting occurs out of Savoonga. Residents of Gambell and Savoonga are the southernmost subsistence bowhead whaling communities in Alaska, taking bowhead, grey whales, and beluga (DCRA, 2014; Downs and Calloway, 2008). Walrus-hide boats are still used to subsistence hunt for marine resources, and onshore, fox are trapped as a secondary source of cash income. Gambell conducts some commercial fishing and creates handicrafts, such as ivory carving, which contributes to their economy.

Savoonga, like Gambell, is located on St. Lawrence Island in the Bering Sea 263 km (164 mi) west of Nome and is located 63 km (39 mi) southeast of Gambell. It is a traditional St. Lawrence Yup'ik community with a subsistence way of life based on walrus and whale hunting. Savoonga is hailed as the "Walrus Capital of the World." The population of Savoonga is 718 and 95% of residents are Alaska Native (DCRA, 2014; Norris, Vines, and Hoeffel, 2012). Savoonga residents harvest a wide variety of subsistence resources and the most prevalent harvest, in terms of usable or edible pounds harvested, are walrus and bearded and other seal. Subsistence hunters also harvest fish, migratory birds, bird eggs and a diverse assortment of plants, berries and seaweeds. In 2010, 14 residents held commercial fishing permits. Reindeer harvests also occur and like Gambell, fox are trapped as a secondary source of income. Residents of Savoonga are known for their ivory carvings with materials acquired from subsistence harvest resources.

Shishmaref, located 203 km (126 mi) north of Nome, 161 km (100 mi) southwest of Kotzebue, and just north of Bering Strait, is located 8 km (5 mi) from mainland Alaska on Sarichef Island in the Chukchi Sea. The community is surrounded by Bering Land Bridge National Preserve lands and is part of the Beringian National Heritage Park. Shishmaref became a supply point for gold mining in the region in 1900 due to its exceptional harbor. The community is subject to severe storm erosion, with major storm events since 1997 causing the relocation of many homes and the National Guard Armory. The population of the community is 589 with 94% Alaska Native (DCRA, 2014; Norris, Vines, and Hoeffel, 2012). Community subsistence harvests depend on reliable access to fish, walruses, seals, polar bears, and small game. Residents manage two reindeer herds and the reindeer skins are locally tanned and meat is available to the community (ADCCED, 2014).

Russian Chukotkan Communities

Russian communities are discussed here since they are home to a predominantly indigenous inhabitant population who rely on subsistence resources. The region and its communities are located away from the Leased Area but subsistence resources they rely on have a chance to be affected by oil and gas activities which would occur in the Leased Area. They are discussed below due to their strong cultural and subsistence resources needs and because the subsistence resources which migrate through the area and would have a probability of passing through the Leased Area.

The Chukotka Autonomous Okrug or Chukotka is a Federal subject of Russia located in the Russian Far East. The autonomous okrug's surface area is 737,700 km^2 (284,800 mi^2). With its principal town and administrative center located in Anadyr, Chukotka is bordered in the north by the Chukchi Sea and the East Siberian Sea, in the east by the Bering Strait and the Bering Sea, and in the south by Kamchatka Krai and Magadan Oblast. The Chukchi Peninsula projects eastward forming the Bering Strait between Russia and Alaska, and encloses the north side of the Gulf of Anadyr. The peninsula's easternmost point, Cape Dezhnev, is also the easternmost point of mainland Russia. Chukotka can be divided into three distinct areas: the northern Arctic desert, the central tundra, and the taiga in the south. About half of its area is above the Arctic Circle. This region is culturally diverse with an ethnic composition, according to the 2010 Census, of Russian 52.5%; Chukchi 26.7%; Ukrainian 6%; Yupik 3.2%; Even 2.9%; Chuvan 1.9%; Belarusians 0.96%; and Yukaghir 0.4% (Russian Federation, 2014).

The region includes the area of East Cape which extends 322 km (200 mi) west and includes the coastal indigenous communities of Naukan (population 350); Uelen (population 678); Inchoun (population 362); Chegitun (a seasonal subsistence camp); Enurmino (population 304); Neshkan (population 628); Alyatki (a seasonal subsistence camp); Nutpel'men (population 155); and Vankarem (184) (Russian Federation, 2014). Other coastal settlements westward from Vankarem are Rigol (population unknown); Mys Shmidta (Cape Shmidt; population 717); Rypkarpyy (population 915); Polyarnyy (population unknown); Pil'gyn (population unknown); Leningradskii (population 835); Billings (Cape Billings; population 272); and Ushakovskoe (population 8) on Wrangel Island. Historically, there were a number of indigenous settlements in the region from Vankarem north to Cape Billings, and there has been a trend toward repopulating settlements (reoccupying seasonal hunting and fishing camps) abandoned earlier due to forced relocation of residents by the Soviet government into larger urban communities. Repopulation has been occurring out of necessity because residents need to harvest natural food sources as subsidies from Moscow to support employment and infrastructure have been disappearing. Of all the above named settlements, only Ushakovskoe is known to still have clear functioning subsistence-harvest practices. Many names that still appear on maps of the region are historical communities that no longer exist and, in some cases, they may be small family camps where a few Native inhabitants live on a seasonal basis. Chukotka is mostly roadless and air travel is the main mode of passenger transport. There are local permanent roads between some settlements. In the winter laid roads are placed on the frozen rivers which connect region settlements in a uniform network. Coastal shipping also takes place, but the ice situation is too severe for at least half the year. The Native people of Chukotka depend on gray whale and bowhead whale hunting for nutrition and as a source of cultural vitality. In the 2009 AMAP Assessment Report, the traditional diet of the coastal residents differs from those residing more inland. Coastal residents not only depend on whale harvests but also subsist on other marine mammals, fish, reindeer meat from inland, other terrestrial mammals, and wild plants (AMAP, 2009).

3.3.2.2. Subsistence Resources and Practices

This section discusses subsistence harvest resources, harvest practices, and seasons of harvests in the communities identified and discussed above, focusing primarily on shared resources and subsistence practices of the permanent residents of the Arctic and Bering Sea coasts who are Alaska Natives. For each of these communities surrounding the Chukchi Sea, along with communities on the Beaufort Sea and in the Bering Strait, subsistence activities are not only fundamental to cultural survival but essential for community and individual health providing a diet that Alaska Natives view as healthier than prepared foods (USDOI, BOEMRE, 2011c, e, f). Subsistence is inextricably intertwined with Alaska Native culture and is key to cultural identity. The harvest and consumption of wild resources are only the most visible aspects of a complex set of behaviors and values that extend far beyond the food quest. Kinship, sharing, and subsistence resource use behaviors (such as preparation, harvest, processing, consumption, and celebration) are inseparable. Beyond dietary benefits, subsistence resources provide materials for personal and family use, and the sharing of resources helps maintain traditional family organization. Harvesting of subsistence sources may differ slightly from community to community.

Many of the most important subsistence resources are found in or near the sea for many of these communities, or utilized by extended family in more inland communities. The cultural value placed on subsistence harvesting, whaling in particular, is found throughout the North Slope and in northwestern Alaska. Subsistence has been described as the “organizing concept for the North Slope Borough” (USDOI, BLM, 2002). The North Slope Borough has also been described as “the most organized, strongest, and best-funded subsistence economy in Alaska” (USDOI, MMS, 2007a). Within the North Slope Borough and Northwest Arctic Borough, both subsistence activities and wage economic opportunities are highly developed and highly interdependent. Since money is needed to purchase resources (such as rifles, ammunition, fuel, snowmachines, ATVs, boats, and motors) to most effectively harvest resources, Native communities most active in subsistence activities tend to also be very involved in the wage economy (USDOI, MMS, 2007a).

In general, subsistence foods consist of a wide range of resources that have substantial nutritional benefits. In addition to health benefits, there are social and cultural benefits to subsistence food harvesting and sharing (USDOI, MMS, 2007a). Marine mammals are culturally most important even in communities where caribou or fish supply more meat. Bowhead whale meat is the most preferred meat by taste and seal oil is a necessary addition to meals as well (USDOI, MMS, 2007a). Subsistence species supply more than meat. Skins and furs go into the production of clothing and paddled skin boats (*umiat*). Bone, baleen, and ivory provide raw materials for handicrafts.

The subsistence harvest plays an important role in all Alaska Native communities of the North Slope and northwest Alaska. However, each community has its unique harvest pattern and preferences. Tables 3-14 – 3-19 provide information on all subsistence resources harvested by residents from NSB communities, NWAB communities, Bering Strait communities, and includes the best available information on Native communities in the Russian Chukotka Autonomous Okrug. Even though these tables identify all resources used by the communities, only the most utilized, important resources are discussed in the narrative.

Subsistence harvesting follows a seasonal pattern constrained by changes in climate and by the migration patterns of whales, fishes, birds, and terrestrial mammals such as caribou. However, subsistence activities may occur year-round in these communities, with seasonal emphases on a particular resource. For ease to the reader, a generalized seasonal scale is being used in this discussion depicting that even though harvesting occurs year-round, it will be divided into the following seasons separated by the months which are in each season respectively (Jorgensen, 1990):

- Spring: April– May
- Summer: June–August
- Fall: September– October
- Winter: November– March

A recent study of subsistence harvesting patterns in Beaufort Sea communities suggests that subsistence marine harvesting can occur anywhere along the coast, but tends to be concentrated in areas directly offshore from the communities and regularly used whaling camps, such as Cross Island, where the community of Nuiqsut stages its fall bowhead hunt (Galginaitis, 2013; Braund, 2010). Most harvesting occurs within 40 km (25 mi) of shore, but rarely extends much past that distance unless necessity warrants it or if conditions of ice and sea allow farther travel. Preference is given to locations where returning harvesters do not have to fight against the currents to bring their harvest home (Braund, 2010).

Hunters from Iñupiat communities and whaling crew members may come from both coastal and inland communities. Bowhead whales, a key harvest species for these communities, are harvested during both the spring and fall in Barrow and Wainwright, and during the spring migration in Point Hope and Point Lay. Nuiqsut and Kaktovik only harvest bowhead whale in the fall (Galginaitis, 2013; Braund, 2013; Braund, 2010). See Table 3-14 for a typical breakdown of international bowhead quotas.

Table 3-14. Arctic Community Bowhead Quotas for 2014.

Community	Region	Quota	Winter	Spring	Summer	Fall
Barrow	North Slope Borough	25		x		x
Gambell	Bering Straits	8	x			x
Kaktovik	North Slope Borough	3				x
Kivalina	NWAB	4		x		
Little Diomede	Bering Straits	2		x		
Nuiqsut	North Slope Borough	4				x
Point Hope	North Slope Borough	10		x		
Point Lay	North Slope Borough	2		x		
Savoonga	Bering Straits	8	x	x		
Wainwright	North Slope Borough	7		x		x
Wales	Bering Straits	2		x		

Most Western Arctic Stock bowheads migrate annually from wintering areas in the northern Bering Sea on the Bering Shelf north of Navarin Canyon through the Chukchi Sea. Most calving occurs in the spring to summer in the Beaufort Sea and Amundsen Gulf in Canada's Northwest Territories (Quakenbush, Small, and Citta, 2010). Some animals remain in the eastern Chukchi and western Beaufort Seas during the summer. In September to mid-October, bowheads head west out of the Beaufort Sea into the Chukchi Sea, often resting and feeding in Camden Bay (Galginaitis, 2013; Quakenbush and Huntington, 2010). See the Marine Mammal Section 3.2.4 for a more detailed discussion of biological behaviors. This migration pattern takes whales past whaling communities on islands in the Bering Sea, along the coast of the Northwest Arctic Borough, and along the shore of the North Slope Borough.

Many studies, such as Galginaitis (2013) and Braund (2013), have utilized Geographic Information Systems (GIS) to identify locations of subsistence resource siting and/or harvest and to identify overlap in use of subsistence areas. GIS tracking was coupled in much of the current research used in this analysis with surveys, asking individual hunters about their own preference in use areas and distances they traveled to obtain resources.

North Slope Borough Community

Barrow

Barrow is situated where both marine and terrestrial mammals are readily available. Hunters target bowhead whale, ringed and bearded seal, and walrus as they migrate north along the Chukchi Sea. Barrow also harvests bowheads in the fall as they return south. Residents harvest fish such as broad whitefish, Arctic grayling, tomcod, and burbot in local rivers and lakes of Elson lagoon. Birds such as loon, eider ducks, geese, and ptarmigan are harvested, along with eggs. Caribou is commonly harvested along with other terrestrial mammals such as moose, other furbearing animals, and berries (Braund, 2010).

Marine Mammals

Bowhead whales (*aġviq*) are commonly harvested during spring and fall hunts. These are the most prized subsistence resource and are central to Iñupiat culture and the well-being of the community. Hunters are organized into whaling crews, usually composed of a captain and about 5 - 15 hunters. Community members and Whaling Captains' wives also play a big role in success of the community harvests. There were approximately 55 registered crews in Barrow in 2012 (Kishigami, 2013; Braund, 2010). Bowhead whales are taken east as far as Smith Bay and as far as Skull Cliff west on the Chukchi Sea. Bowhead whale harvest areas are up to 32 km (20 mi) offshore between the Walakpa River to the west and Cooper Island to the east and off the coast near Wainwright in the past 10 years (Braund, 2010, Map 10). Whaling crews use boats and snowmachines to access bowhead whale hunting areas. Whaling crews travel in hand paddled umiat to open leads during the spring and power-driven aluminum boats to hunt in open water during the fall (Braund, 2010). Spring whale hunting usually occurs in April and May, though it can occur later, and may vary yearly depending on the location of the open lead. Braund (2010), in interviews with hunters, observed that the spring lead has been closer to shore in recent years with distances hunters had to go out ranging between 26 km to 0.40 km (16 mi to 0.25 mi). Fall hunting usually occurs during September and October and depends on various factors including the location of migrating whales. Braund (2010) noted that one season, hunters traveled east to Cape Simpson due to an ongoing seismic project and diversion of migrating whales. The primary location of the fall hunt is 35 km (22 mi) north of Barrow. Other locations for the fall hunt are to the east and northeast of Barrow. During fall, no hunting is reported near Wainwright. Bowhead whale hunting areas in fall vary yearly due to migration patterns, weather, and ice conditions, but most residents prefer to harvest closer to the community for safety reasons and to ensure that the whale meat will not be spoiled (Braund, 2010). Fall harvests are usually day trips whereas spring harvests occur over extended periods.

For the purposes of discussion related to bowhead whales, a differentiation of strikes versus landing as defined in 50 CFR Sect. 230.2 will be utilized. Striking a whale does not necessarily mean landing the whale, thus having a successful harvest season. These terms are as follows:

- Strike means hitting a whale with a harpoon, lance, or explosive device.
- Landing means bringing a whale or any parts thereof onto the ice or land in the course of whaling operations.

In terms of total weight of harvested animals, bowhead whales typically dominate the harvest at Barrow. Whales are harvested in spring and fall with a quota of 25 bowhead whale strikes for the year (AEWC, 2014). Whales landed since the 2011 SEIS have been (Suydam and George, 2013, 2012):

- 2012- 24 Total (Spring: April=9, May=5; Fall: October=10) Barrow also landed 5 beluga whales in the summer of 2012 (Suydam and George, 2012)
- 2013 -22 Total (Spring: June=1, July=1; Fall: September=18, October=2)

Seals are harvested by Barrow residents, and bearded seal (*ugruk*) is the most important seal resource harvested, providing not only meat and seal oil for consumption, but also components for the building of umiat used for spring whaling. Bearded seal are hunted east as far as Prudhoe Bay and as far west as Wainwright. Some hunts for bearded seal have occurred as far offshore as 24-32 km (15-20 mi) from the point near Skull Cliff. Bearded seal hunting occurs primarily between June and August, with July being the peak month for harvest; however, bearded seal has been reported as taken year round, and access to the hunting areas is primarily by boat. Ringed seal (*natchiq*) is also harvested for meat and oil, but to a lesser extent than bearded seal. Ringed seal harvest areas are similar to bearded seal areas, and access to the hunting areas is primarily by boat or snowmachine. It has been reported that some hunters have traveled 35 miles (56 km) north of Barrow Point to harvest ringed seal. Nunavak Bay, southwest of Barrow on the Chukchi Sea, is identified as a favored ringed seal hunting area

(Braund, 2010). Hunting for ringed seal peaks June through August but ringed seals are harvested year round and access to hunting areas is primarily by boat or snowmachine.

Walrus (*aiviq*) hunting generally occurs while looking for bearded seal near the icepack during the summer. For Barrow, walrus hunting areas are similar to bearded seal areas but extend farther from shore and farther west beyond Wainwright. Braund (2010) found that some residents have traveled 40-48 km (25-30 mi) and as far as 64-113 km (40-70 mi) to get a walrus. The primary harvest months for walrus are June through September with the most active month of harvest being July. Walrus may be taken year-round and hunting areas are accessed by boat or snowmachine.

Terrestrial Mammals

Caribou (*tuttu*) are commonly harvested year-round and have been taken as far east as Dease Inlet to Prudhoe Bay and as far west as Skull Cliff and Peard Bay to Icy Cape on the Chukchi Sea coast. Summer and fall hunting occurs either along the coast, along local rivers, or overland as far as the Inaru River. Peak hunting for caribou is July through September and occurs by boat in summer and fall along the coast and inland along various rivers. In the winter, caribou are taken as needed. Caribou are least likely to be taken in April and May (Braund, 2010).

Moose (t*uttuvak*) are considered rare in the Barrow area and the preference by residents is for caribou. Many hunters hunt moose only when they present themselves while hunters are looking for other resources (Braund, 2010). Moose are more commonly harvested by non-Iñupiat residents of Barrow. (Braund, 2010; Map 12) Two separate moose hunting seasons are identified in February to April and August to September and access to hunting areas is by boat or snowmachine.

Wolf (*amaġuq*) and wolverine (*qavvik*) hunting is less common that other subsistence pursuits because it generally requires long-distance travel during cold winter months. Harvest areas extend as far west as Point Lay and east past the Kuparuk River. Harvest areas for wolf and wolverine are similar to those of caribou, and hunters have reported that they often do not encounter them until they are south of the community, near Atqasuk (Braund, 2010, Maps 35-36). Wolf and wolverine are hunted from October through June with February and March being preferred hunting months. Since the majority of these hunts occur in winter, access is primarily by snowmachine.

Fish

Arctic Cisco (*qaaktaq*) are available in limited supply near Barrow and only in certain locations. Some residents travel to the Nuiqsut area to harvest them. Near Barrow, harvest of Arctic Cisco occurs primarily in Kuyanak Bay and some are harvested incidentally by nets in Elson Lagoon and toward the mouth of the Inaru, Meade, and Chipp Rivers. Inland, harvesting occurs near the Usuktuk River near Atqasuk and near Teshekpuk Lake. Arctic Cisco are best harvested right after freeze-up and harvests occur in all months except January and April with the greatest harvest period from July to November.

Arctic char/Dolly Varden (*paikluk/iqalukpik*) are harvested near Barrow in Elson Lagoon and near the Inaru, Mead, and Chipp Rivers of Dease Inlet. Arctic char/Dolly Varden have also been harvested by Barrow residents near Peard Bay and the Kugrua Rivers adjacent to the Leased Area. Most harvest occurs in July and August but these fish have been harvested as early as May and as late as December and access to the use areas is by boat and snowmachine.

Broad whitefish (*aanaakliq*) harvesting is a common activity among Barrow residents and provides a substantial amount of their annual harvests in comparison to other fish resources (Braund, 2010). These fish are harvested are as far east as the Colville River. There is also fishing south of the community in Lake Sungovoakm, Walakpa Bay and Peard Bay on the Chukchi Sea. Braund (2010) cited a resident who observed that broad whitefish on the Inaru River, near Dease Inlet, had been scarce for some years since seismic testing, but noted that these fish are making a comeback in the drainage. The majority of harvesting of broad whitefish occurs July through October. Unlike Arctic Cisco, broad whitefish are best harvested "right before freeze-up" and some harvesting does occur in other months (Braund, 2010). Boats and snowmachines are used most often to access harvest areas.

Burbot (*tittaaliq*) are usually caught incidentally in nets during other subsistence pursuits or when residents ice fish in winter months. Many of the burbot harvested by Barrow residents are given to community elders, friends, or family (Braund, 2010). Burbot areas are similar to the broad whitefish areas listed above. Burbot is harvested year round with the highest numbers harvested from June through November. Snowmachines and boats are used to access harvest areas.

Birds

Geese are hunted by most residents and include white fronted geese (*niġliq*), Canada geese (*iqsraġutilik*), brants (*niġliñġaq*), and snow geese (*kaŋuk*). Geese are customarily shared by whaling crews at the Nalukataq festival. Harvesting occurs as far east as Teshekpuk Lake and south past Walapka bay, Peard Bay, and past Wainwright (Braund, 2010). Harvest of geese usually occurs in May. This is the main goose hunting time after the spring bowhead whale hunt. Harvest can occur in April and again June through October. Snowmachines are the primary access to hunting use areas.

Eiders are hunted on the ice when the lead is closed so whaling efforts are not disrupted. Hunting for both king (*qiŋalik*) and common (*amauligruak*) eiders generally occurs in spring and summer and can occur in tandem with bowhead whale hunting. Hunts occur offshore between north of Barrow at a location called Piġniq, and in the Chukchi Sea near Peard Bay to the Tapkaluk Islands, near Wainwright, and on the Inaru and Meade Rivers. Hunting for eider occurs throughout the spring, summer and fall, with the highest number of harvests in May and August. Braund (2010) identified that based on community reports, no eiders are taken December through March. Most harvest areas are accessed by snowmachine and boat.

Wainwright

Wainwright is one of the communities situated closest to the Leased Area, and its residents harvest both marine and terrestrial mammals. In 2012, the most productive harvest year in recent memory, hunters targeted bearded seal, walrus, and beluga whale most frequently. In the same year, most harvests occurred during June and July, with other harvests occurring in April and May (Braund, 2013). Residents harvest other marine and terrestrial subsistence resources such as bearded, ringed, and spotted seal, fish, waterfowl, and caribou. In 2012, Wainwright harvested one brown bear. Wainwright had a quota of 7 whale strikes from the International Whaling Commission (IWC) block quota 2008-2012 (NSB, 2014a). In 2012, spring whaling for bowhead began in April and May with no fall bowhead hunt conducted. In 2013, no spring hunt occurred; only a fall bowhead whale hunt was conducted (Suydam and George, 2013).

Marine Mammals

Bearded seals are identified as the most harvested resource, providing meat and oil for consumption. Ringed and spotted seal (*Qasigiaq*) are also harvested for meat and oil, but to a lesser extent than bearded seal. Bearded seal are hunted from Icy cape in the south to Peard and Kugrua Bays in the north. Some hunts for seal have occurred as far offshore as 59 km (37 mi) offshore from Wainwright (Braund, 2013). Bearded seal hunting primarily occurs between June and August with July being the peak month for harvest. Ringed seal harvest areas are similar to bearded seal areas and the months of harvest are June through August.

Beluga whales (*Quilaluagaq*) are harvested primarily in July by the community and these harvests can vary from year to year based on varying conditions. In 2012, 34 beluga whales were reported harvested. This number was up from 2011 where 10 were harvested and 2010 where 11 were harvested (Goodwin, 2011, 2012, 2013). Most of the beluga hunting occurs at the entrance to

Wainwright Inlet where the shallow water allows hunters to herd the whales into the area and to collect those harvested. This harvest is rapid and intensive, with all belugas taken from 2010-2012 in July (Braund, 2013).

Bowhead wales are commonly harvested during spring and fall hunts. Harvesting of bowhead is concentrated north and east of the community and extends from Point Franklin in the north and southwest toward Pingorarok Pass. In 2010, the average distance traveled offshore to hunt bowhead whale was reported to be just over 49 km (30 mi) with distances of up to approximately 64 km (40 mi) reported (Braund, 2013). Spring whale hunting usually occurs in April and May, and in 2012 and 2013, Wainwright harvested 4 and 0 bowhead whales respectively (Suydam and George, 2012, 2013). In 2012, the spring leads closed in mid-April and remained closed through June due to wind conditions. The primary months of harvest for bowhead whales for Wainwright are April and May with the focus on other resources such as bearded seal, walrus, and ringed seal beginning in June. Wainwright successfully harvested its first fall bowhead whale in approximately 70 years in 2010 and harvested another fall bowhead in 2011. In 2013, fall whaling occurred during September and October, with three whales harvested.

Walrus hunting generally occurs along the coast a few miles south of the Kuk River and north to a location 10 miles (16 km) west of Point Franklin. Walrus hunts usually occur no more than 16-32 km (10-20 mi) offshore (Braund, 2013). The primary harvest months for walrus are June through July with some harvesting through September.

Wainwright harvests polar bear which are managed by the Alaska Nanuuq Commission (ANC), local communities, and the USFWS. In June 2010, the Commission agreed to a joint quota of 58 polar bears, of which no more than 19 will be females, to be split evenly between the U.S. and Russia. In early 2013, the harvest limit was to take effect when a new management system was in place allowing Alaska the quota of 29 bears (the U.S. share of the total quota for the population). Polar bears are harvested every month except June with the majority of harvest occurring October through January (USFWS, 2009).

Terrestrial Mammals

Caribou are commonly harvested inland along the rivers with some coastal hunting in the summer. Coastal caribou are hunted from Kasegaluk Lagoon to approximately 32 km (20 mi) northeast of Wainwright (Braund, 2013). When harvesting caribou, hunters travel no more than 3 km (2 mi) from the coast. Hunting for caribou occurs July through September.

Fish

Salmon are the primary fish taken and harvesting occurs in Wainwright Inlet, while hunting for bearded seal. Coastal fish are harvested in smaller quantities than freshwater fish, but residents do harvest rainbow smelt, the main coastal fish harvested during winter months.

Birds

Waterfowl are hunted by most residents and include brants, king and common eiders, and ducks. Wainwright residents harvest waterfowl close to shore, usually no more than 16 km (10 mi), and harvesting occurs from April through July from Akoliakatat Pass south to Point Franklin in the north.

Point Lay

Point Lay is the next community situated closest to the Leased Area and its residents harvest both marine and terrestrial mammals. In 2012, the most targeted marine mammal subsistence resources were bearded seal and beluga whale. Other targeted resources for Point Lay in 2012 were caribou, salmon, eiders, and eggs. In the same year, most harvests occurred during June through August. In 2011 and 2012, most offshore hunts occurred no more than 32 km (20 mi) offshore in the Chukchi Sea. Point Lay had a quota of two whales from the IWC block quota 2008-2012 (NSB, 2014a) and in

2012, spring whaling for bowhead was in April with only one bowhead whale landed. No whales were landed in Point Lay during the 2013 whaling season (Suydam and George, 2013).

Marine Mammals

Bearded seals are identified as the most harvested resource, and provide meat and oil for consumption. Ringed and spotted seal are also harvested but to a lesser extent than bearded seal. Seals are hunted from Omalik Lagoon in the south; the northern hunting areas vary and extend as far north as Wainwright, and have occurred as far offshore as 24 km (15 mi) (Braund, 2013). Seal hunting primarily occurs between April and August.

Beluga whales are harvested in June and July by the community, but harvests can vary from year to year based on conditions. Similar to Wainwright, beluga hunting is a community event for Point Lay. Scouts stay close to the coastline looking for whales and when a pod is located, hunters herd the pod through Five-mile or Eleven-mile Pass and into the shallow waters of Kasegaluk Lagoon directly in front of Point Lay for harvesting (Braund, 2013). The annual beluga hunt occurs in June or July. In 2012, 14 beluga whales were reported harvested. This number was down from 2011 where 23 beluga were harvested and 2010 where 22 were harvested (Goodwin, 2011, 2012, 2013).

In 2008, Point Lay became the 11th Alaska whaling community to resume traditional bowhead whaling and landed its first bowhead in over 70 years in 2009 (Suydam et al., 2009). In 2009, Point Lay attempted to conduct a fall hunt but only had success in the 2009 spring hunt. In 2009, Point Lay had a IWC/AEWC quota of one bowhead per year which was increased to two in 2014. If they harvest a bowhead whale in spring, they do not attempt to harvest again in fall. Bowhead wales are commonly harvested by Point Lay during spring hunts occurring in April and May. Harvesting of bowhead whales occurs north of Utukok Pass and directly off of Point Lay and Cully Inlet in leads at a distance of 16-32 km (10-20 mi) offshore (Braund, 2013). In 2012 and 2013, Point Lay harvested one and zero spring bowhead whales respectively (Suydam and George, 2012, 2013). Again, this was due to the spring leads closing in mid-April due to wind conditions.

Walrus hunting generally occurs within Kasegaluk Lagoon and north to Icy Cape. Walrus hunts usually occur nearshore, primarily during the month of June (Braund, 2013). In 2012, three walrus were harvested.

Terrestrial Mammals

Caribou are commonly harvested along the coast with in Kasegaluk Lagoon and north to Icy Cape during the months of June through October. The peak harvests occur in July and August. Point Lay hunters also harvest caribou inland and in 2012, 36 caribou were harvested, up from 19 and 2 in 2011 and 2010 respectively.

Fish

Residents of Point Lay primarily subsistence fish for salmon, flounder, herring/smelt, and trout. Fishing occurs south from Point Lay to Naokok Pass and occurs in conjunction with berry picking during July and August.

Birds

Waterfowl are hunted by most residents, primarily from April through June. Harvest of waterfowl by Point Lay is in an area 16-32 km (10-20 mi) offshore from Naokok Pass south to just offshore from Point Lay. Eggs are gathered from June through July and according to Braund (2013; Map 76), residents travel offshore to gather eggs at a distance of up to over 32 km (20 mi).

Point Hope

Point Hope is located at the south portion of the Leased Area and just north of Kivalina and Cape Stebbings. Marine mammal harvests for this community can be quite variable due to ice and weather conditions. Point Hope also harvests fish, birds, eggs, terrestrial mammals, and berries.

Marine Mammals

Point Hope conducts whale hunting activities in spring for both bowhead and beluga whales between April and May. Point Hope has a IWC/AWEC quota of 10 bowhead whales annually (AEWC, 2014). In spring of 2012, Point Hope harvested five bowhead whales during the spring hunt, and in 2013 the community harvested six bowhead whales (Suydam et al., 2012; Suydam and George, 2013). Point Hope also harvests other marine mammals including beluga whales, bearded seals, and walrus. Hunting for bearded seal and ringed seal occurs from June through July, and some ringed seal hunting has occurred during September and October (Fuller and George, 1999). Walrus hunting occurs during June and July for the Point Hope community.

Point Hope also harvests polar bear in every month except June and harvests usually occur after December, with the highest harvests in January. More recently, more bears have been harvested in October-December (USFWS, 2010). Like Wainwright, these harvests are covered under the U.S. – Russian Agreement setting a shared quota for harvests.

Terrestrial mammals

Terrestrial mammals are also harvested, with caribou being the primary species harvested. Caribou from the WAH are seasonally available and tend to move into the eastern boundary of Point Hope hunting area in July, and are primarily hunted from July through December. Other terrestrial mammals hunted are moose, Dall sheep, and arctic fox.

Fish

Marine and freshwater fishes are also an important resource in Point Hope, particularly arctic cod, arctic grayling, Dolly Varden, trout, salmon, whitefish, and smelt. Fishing occurs primarily in July and August but fish can be harvested year-round. Fishing activities have been divided offshore into a summer open water fishery for salmon and trout and an autumn/winter under-ice fishery for grayling and cod (Fuller and George, 1999).

Birds

The most important bird resources to Point Hope are king and common eiders, snow geese, brant, greater white-fronted geese, and willow ptarmigan. Snowy owls are also regularly harvested at Point Hope and Murre eggs are gathered at Cape Thompson, southeast of Point Hope, or at Cape Lisburne, northeast of the community during July along with hunting for waterfowl.

Atqasuk

Atqasuk is located inland from the Chukchi Sea, east of Wainwright and south of Barrow. This community practices traditional subsistence harvests onshore, and the area surrounding the community is rich in caribou, other terrestrial mammals, fish, waterfowl, and berries. A few hunters access areas of the Chukchi and Beaufort Sea coasts for seals and other marine resources. While residents consume a wide variety of marine resources, only a small portion of those are acquired on coastal hunting trips initiated in Atqasuk. Most are acquired on coastal hunting trips initiated in Barrow or Wainwright. Some Atqasuk hunters are members of Barrow whaling crews and return to Atqasuk from successful whale hunts with shares of bowhead whale for the community (USDOI, BLM, 2012). Atqasuk subsistence harvesters rely on a diversity of seasonally abundant resources in the area. However, December and January are generally not productive months for subsistence pursuits because of winter weather and darkness. Hunters seeking furbearing terrestrial mammals travel substantial distances from the community to harvest wolves, foxes, and wolverines, with peak harvests January through March (depending on snow conditions). Residents harvest fish from June through November, with the highest harvest months being August through October. Residents may also begin fishing under the ice on the Meade River, its tributaries, and any lakes that do not freeze completely (USDOI, BLM, 2012). Atqasuk is similar to Barrow and Nuiqsut in that residents harvest caribou, moose, bear, furbearers, fish, birds and eggs, and berries.

Terrestrial Mammals

Caribou is the most important subsistence resource, by weight, harvested by Atqasuk residents. A subsistence harvest survey conducted by the North Slope Borough Department of Wildlife Management, covering the period from July 1994 to June 1995, noted 187 reported caribou harvested by Atqasuk hunters (Hepa, Brower, and Bates, 1997). In a July 1996–June 1997 survey, an estimated 398 caribou were harvested (Bacon et al. 2009). Caribou are hunted in two seasons from August through November and again February through May from hunting camps along the Meade, Inaru, Topaguruk, and Chipp river drainages (which are also used for fishing) and these areas are accessed by boat, snowmachine and on foot (USDOI, BLM, 2012).

Furbearer hunting is generally incidental to caribou hunting and involves considerable travel over a widespread area by snowmachine (USDOI, BLM, 2012). Hunting of furbearers occurs most frequently between January through March and less frequently in April, November, and December.

Fish

Fish is a preferred food in Atqasuk and it is the second most important resource in quantity harvested (USDOI, BLM, 2012; ACI, Courtnage, and SRB&A, 1984). Humpback whitefish, least cisco, broad whitefish, burbot, grayling, and chum salmon are usually harvested in the summer through fall and in winter. Narvaqpak (southeast of Atqasuk) is a popular fishing area (NSB, 1998). Most fishing occurs along the Meade River, only a few miles from the community; however, fish are also pursued in most rivers, streams, and deeper lakes of the region. Fish camps are located on two nearby rivers, the Usuktuk and the Nigisaktuvik, and downstream on the Meade River, near the Okpiksak River (Craig, 1987).

Birds

Atqasuk residents harvest migratory birds, especially white-fronted geese, from late April through June when they begin to appear along rivers, lakes and the tundra, following the snowline north (NSB, 1998). Hunters also harvest ptarmigan and from late August through September; other waterfowl are hunted in June and July along the major rivers (e.g., Meade River and its tributaries), and on numerous lakes and ponds. Waterfowl eggs are gathered in the immediate vicinity of the community for a short period in June, and generally are gathered within 50 miles (80 km) of the community (USDOI, BLM, 2012). Atqasuk conducts some harvests of birds year-round. A subsistence harvest survey conducted by the North Slope Borough Department of Wildlife Management reported that bird harvests by Atqasuk hunters represented 3% of the total subsistence harvest in edible pounds (Hepa, Brower, and Bates, 1997).

Nuiqsut

Nuiqsut is located on the western shore of the Colville River, along the Nigliq Channel, approximately 17 miles (27 km) upriver from the Beaufort Sea. This community is part of the discussion since it shares resources which migrate through the Leased Area or adjacent areas. These migratory subsistence resources, such as bowhead whale, seals, caribou, Arctic Cisco and geese, comprise a large part of the subsistence diet in this community. Nuiqsut residents hunt a variety of both marine and terrestrial resources which include fish, birds, eggs, moose, other terrestrial mammals, and berries. For fall whale hunts, this community, in 1986, developed the Oil/Whalers

Agreement, a cooperative agreement which is a mechanism for avoiding conflict between the oil industry and whalers. The primary mechanism for conflict avoidance is through a communications system along with a method for dispute resolution (Galginaitis, 2013). Primary months of whale hunting occur during August through October with peak harvests occurring in September (Braund, 2010). In fall 2012, Nuiqsut landed four bowhead whales, and has a quota of four whale strikes from the IWC block quota 2008-2012 (NSB, 2014a). In fall 2013, Nuiqsut landed four bowhead whales during the season, fulfilling their annual quota for a second year (Suydam and George, 2013).

Marine Mammals

Bowhead whales are commonly harvested during fall hunts which occur August through October. Harvesting of bowhead is concentrated at Cross Island and has, since 1982, been occurring earlier each season (Galginaitis, 2013). During the years 2007-2012, the farthest distance traveled from Cross Island was 21.4 km (13.3 mi) to obtain whale strikes. Historically, whale hunters have traveled as far offshore as 80 km (50 mi) to hunt or scout and recently (between 2007-2012), the distance traveled offshore to hunt/strike bowhead whale has decreased and was reported to be 18.3 km (11.4 mi) (Braund, 2010; Galginaitis, 2013). During the 2012 and 2013 season, Nuiqsut landed four bowhead whales each season in September (Suydam and George, 2012, 2013).

Ringed and bearded seals are identified as the most harvested resources, and residents of Nuiqsut have stated they have an equal subsistence preference for both species, describing seal hunting as an enjoyable summer activity (Braund, 2010). Ringed seal are harvested from Cape Halkett to Camden Bay, and offshore 32-40 km (20-25 mi) from the Colville River Delta between Atigaru Point and Thetis Island. A few hunters have reported traveling offshore up to 64 km (40 mi) to harvest ringed seal (Braund, 2010). Ringed seals are usually harvested by boat or snowmachine during May through October with the most harvests occurring in July. Bearded seals are harvested generally in the same areas as ringed seal. Bearded seal hunting primarily occurs May through October with July being the peak month for harvest. Bearded seal harvest occurs in the open ocean by boat, primarily outside the mouth of the Colville River.

Nuiqsut residents rarely see walrus close enough to the community to hunt them. Walrus have been seen near Cross Island but are not usually hunted because the focus is on whaling and the noise made firing the weapons could frighten whales further out to sea (Braund, 2010).

Terrestrial Mammals

Caribou are an important terrestrial subsistence resource in Nuiqsut, providing a substantial amount of subsistence food for residents each year (Braund, 2010). Nuiqsut commonly hunts caribou from the Beaufort Sea coast south to the foothills of the Brooks Range and from the Sagavanirkok River and Prudhoe Bay to Barrow and Atqasuk. Hunting for caribou occurs throughout the year, with June through September being primary harvest months. Residents utilize boats along the Colville River and along the Beaufort Sea coast to hunt (Braund, 2010).

Moose harvest for Nuiqsut, unlike Barrow and Kaktovik, occur on a regular basis. Moose are generally more available in the area, and hunting occurs primarily along the Colville River south of the community, along Fish Creek and the Itkillik River by boat. Hunts occur in August and September (Braund, 2010).

Fish

Fish harvested by Nuiqsut are Arctic cisco, Arctic char/Dolly Varden, broad whitefish, and burbot. Fishing occurs in, but is not limited to, the Colville River Delta, along the Colville River to Sentinel Hill, the mouth of the Chandler River, and in various inland lakes. Fish are harvested year-round with primary months for Arctic Cisco (October-November), Arctic Char/Dolly Varden (August-September), broad whitefish (June – August), and Burbot (December – February).

Birds

Waterfowl are hunted by most residents and the primary species hunted are white-fronted geese (*nigliq*), followed by Canada geese (*israqgutilik*), brants, and snow geese. Harvest of geese is close to shore, along the Colville River and its tributaries. King and common eider are hunted, often while hunters are harvesting seal. Eider hunting has been reported as far offshore as 64 km (40 mi) directly north of the Nigliq Channel (Braund, 2010). Harvest months for geese are April through June with most harvests in May. Harvest months for eider are May through September with the highest number of harvests in July.

Kaktovik

Kaktovik is located on Barter Island just off the Beaufort Sea coast and is approximately 145 km (90 mi) west of the Canadian border and north of the ANWR. Like Nuiqsut, subsistence hunting, fishing, and whaling play a major role in the cultural way of life and economy of this community. Subsistence hunting is a vital part of life for the people of Kaktovik and due to the cultural and nutritional importance of these resources, this community is part of the discussion since many resources Kaktovik utilizes may migrate through the Leased Area and adjacent areas. Both marine and terrestrial animals are hunted. The most important subsistence marine mammals hunted are whales, seal, and walrus. Kaktovik practices shore-based whaling for bowhead whales in the fall. Primary terrestrial mammals hunted are caribou and sometimes moose.

Marine Mammals

Bowhead whales are commonly harvested during fall hunts with hunters traveling great distances to harvest them (Braund, 2010). Kaktovik whale hunters travel up to 80 km (50 mi) in search of whales between Camden Bay and Nuvagapak Lagoon east of the community. However, most hunters reported staying within 24-48 km (15-30 mi) of shore which ensures landed whales can be towed safely to shore with little meat spoilage (Braund, 2010). Whaling crews use aluminum boats during the hunt, which occurs July through October, with the peak of the harvest in September. Kaktovik has a quota of three whale strikes from the IWC block quota 2008-2012 (NSB, 2014a). During the 2012 and 2013 season, Kaktovik landed three bowhead whales each season with landings in September and October in 2012, and August and September in 2013 (Suydam and George, 2012, 2013).

Bearded seals and ringed seals are identified as harvested resources and bearded seals, along with bowhead whales, are the primary marine mammal hunted by residents of Kaktovik (Braund, 2010). Residents have indicated that ringed seal hunting is less common than in the past because there are “no dogs” and “people used to use it for dog food” (Braund, 2010). Ringed seal are harvested in conjunction with looking for bearded seal between Prudhoe Bay and Demarcation Bay up to 40 km (30 mi) offshore. Ringed seals are usually harvested by boat or snowmachine during March through September. Most harvests occur after the ice breaks up in July and through August. Bearded seals remain an important source of food for many Kaktovik residents and they are harvested generally in the same areas as ringed seal. Hunters have traveled as far offshore as 48 km (30 mi) in search of bearded seal but prefer to hunt them closer to shore, up to 8 km (5 mi) (Braund, 2010). Bearded seal hunting begins in March, peaks in July and August, and concludes in September.

For Kaktovik, walrus are rare in the area and only harvested when they are available during other hunts. Hunting generally occurs while looking for bearded seal near the icepack during the summer. Walrus harvests have reportedly been the highest in July.

Terrestrial Mammals

Caribou hunting is a key subsistence activity for Kaktovik residents. Caribou are available onshore, along the coast during the summer months, and inland throughout the year. Harvest areas are as far west as Ikpikpuk River and east, beyond the Mackenzie River Delta in Canada. Along the coast, residents hunt caribou between Bullen Point and Demarcation Bay. Hunts for caribou are year-round and occur with the aid of boats or snowmachine, with July and August as the peak hunting months (Braund, 2010).

Moose harvests are rare, and most Kaktovik residents have stated they do not like the taste of moose (Braund, 2010). The highest month for harvest is April by snowmachine, and moose are generally available inland if Kaktovik residents choose to harvest them.

Fish

Fish taken and harvested by Kaktovik are Arctic cisco, Arctic char/Dolly Varden, broad whitefish, and burbot. Fishing occurs in, but is not limited to, the Sagavanirkok River to the Mackenzie River delta, and in various inland rivers and lakes. Fish are harvested year-round with nets and rod or reel along the coast and along barrier islands near Barter Island (Arey Island, Bernard Spit). Primary harvest months for fish are; Arctic Cisco (July-August), Arctic Char/Dolly Varden (July-August), broad whitefish (July-August), and Burbot (July-August).

Birds and eggs

Waterfowl, particularly geese and eiders, are hunted by most residents. The four goose species hunted by Kaktovik residents include brants, white-fronted geese (*nigliq*), Canada geese (*israqgutilik*), and snow geese. Harvest of geese is close to shore and along inland rivers during the months of April through October. In Kaktovik, eider duck hunting is less common than goose hunting and often occurs as the opportunity presents itself when hunting for other resources (Braund, 2010). Residents hunt both king and common eiders usually in the same area and at the same time as goose hunting is occurring (Braund, 2010). Harvest months for both geese and eider are May through September with most harvests in May. In 2009, North Slope villages reported harvesting 10,411 birds, and Barrow alone harvested an additional 8,664 birds. In 2009, North Slope villages reported harvesting 2,341 eggs, with Barrow harvesting 88 eggs (Naves and Braem, 2014).

Table 3-15 identifies reported subsistence harvest resources for seven NSB communities from 1987 through 2012.

Table 3-15. Reported Subsistence Resources Used by NSB Communities.

Resource	Native Communities						
	Barrow	Wainwright	Point Lay	Point Hope	Atqasuk	Nuiqsut	Kaktovik
Marine Mammals							
Bowhead whale	X	X	X	X	X	X	X
Beluga whale	X	X	X	X	X		X
Bearded seal	X	X	X	X	X	X	X
Spotted seal	X	X	X		X	X	X
Ringed seal	X	X	X	X	X	X	X
Ribbon seal	X	X	X		X		
Walrus	X	X	X	X	X		X
Polar Bear	X	X	X	X	X	X	X
Terrestrial Mammals							
Caribou	X	X	X	X	X	X	X
Moose	X	X	X	X	X	X	
Wolf	X	X	X		X	X	X
Wolverine	X	X	X		X	X	X
Brown bear	X	X	X		X	X	
Dall sheep	X	X		X	X	X	X

Resource	Native Communities						
	Barrow	Wainwright	Point Lay	Point Hope	Atqasuk	Nuiqsut	Kaktovik
Muskox	X	X			X	X	X
Arctic fox (blue)	X	X	X		X	X	X
Red fox	X	X	X		X	X	
Porcupine	X	X					
Ground squirrel	X	X	X		X	X	X
Weasel	X	X			X	X	
Marmot	X	X	X		X	X	X
Salmon							
Chum	X	X	X	X	X	X	
Pink (humpback)	X	X		X	X	X	
Silver (coho)				X		X	
Whitefish							
Round whitefish	X	X					
Broad whitefish	X	X			X	X	X
Humpback whitefish	X	X			X	X	
Least cisco	X	X			X	X	X
Bering and Arctic cisco	X	X	X		X	X	X
Other Freshwater Fish							
Arctic grayling	X	X	X	X	X	X	X
Arctic char	X	X	X	X	X	X	X
Burbot (ling cod)	X	X			X	X	
Lake trout	X	X			X	X	
Northern pike	X	X					
Other coastal fish							
Rainbow smelt	X	X	X			X	
Arctic cod	X	X			X	X	X
Tomcod	X	X	X	X	X		X
Flounder				X			X
Birds							
Snowy owl		X		X		X	
Red-throated loon	X	X	X				
Tundra swan		X			X	X	X
Common eider	X	X	X		X	X	
King eider	X	X	X		X	X	
Spectacled eider	X	X	X				
Steller's eider	X	X	X				
Other ducks	X	X		X	X		
Pintail		X	X		X		X
Long-tailed duck	X	X	X		X		X
Surf scoter	X	X					
Brant	X	X	X	X	X	X	X
White-fronted goose	X	X	X		X	X	X
Snow goose	X	X	X		X	X	X

Resource	Native Communities						
	Barrow	Wainwright	Point Lay	Point Hope	Atqasuk	Nuiqsut	Kaktovik
Canada goose	X	X	X		X	X	X
Ptarmigan	X	X			X	X	X
Willow ptarmigan	X	X	X				
Other Resources							
Berries	X	X	X	X	X	X	
Cranberry	X	X					
Salmonberry	X	X					
Bird eggs	X	X	X	X	X		
Gull eggs		X			X		
Goose eggs		X			X		
Eider eggs	X	X			X		
Greens/roots	X	X			X	X	X
Wild rhubarb	X	X					
Wild chives	X	X					
Clams	X	X	X				
Crab		X	X	X	X	X	

Note: (X indicates reported use of a resource; Blank means no reported use 1987-2012)
Sources: Galginaitis, 2013; Braund, 2013; BOEM, 2012; ADF&G, 2014c.

Northwest Arctic Borough (NWAB)

For this discussion, the NWAB communities will be discussed in aggregate since many of the subsistence resources are shared and would migrate through the Leased Area or adjacent areas. The coastal NAWB communities of Kivalina, Kotzebue, Buckland, and Deering are located inland of the Chukchi Sea and could be affected. Other communities in the region that have ties to the regional coastal communities are Ambler, Kiana, Noatak, Noorvik, Selawik, and Shungnak. Migrating whales and many of the other marine and terrestrial mammals that are hunted by North Slope Borough communities previously discussed are also hunted by Northwest Arctic Borough communities. Any effects on marine or terrestrial mammal populations migrating along the northern coast would also be felt by Northwest Arctic Borough communities along the coast as well as the inland communities that trade with them. Migrating whales continue south to the Bering Sea, and similar effects could also be felt in the Alaska Native whaling communities of Wales, Diomede, Savoonga, Gambell, Shsimaref, and in traditional Russian whaling communities, which will be discussed later based on their locations along the migratory pathway.

Marine Mammals

Bowhead whales are harvested by the community of Kivalina in the NWAB. The AEWC website indicates that Kivalina has an annual quota of four bowhead whale strikes, and during the March 2013, Arctic Open Water meeting, it was stated that the 2012 bowhead whale harvest was under the IWC strike quotas allotted. In 2012, whaling communities had 69 strikes, harvesting 47 whales (IWC, 2014). The bowhead whale subsistence quota had been renewed by the IWC and when harvesting the Bering-Chukchi-Beaufort Seas stock of bowhead whales, a total of up to 280 bowhead whales was available to be landed from 2008 - 2012, with no more than 67 whales struck in any year (and up to 15 unused strikes may be carried over each year) shared between the U.S. and Russian Native people (IWC, 2014; NMFS, 2013c). Most Western Arctic Stock bowheads migrate through their region annually from wintering areas in the northern Bering Sea through the Chukchi Sea, where most calving occurs, spending spring to summer in the Beaufort Sea and Amundsen Gulf in Canada's Northwest Territories (Quakenbush, Small, and Citta, 2010). In September to mid-October, bowheads head west out of the Beaufort Sea into the Chukchi Sea, often resting and feeding in Camden Bay. In fall, their migratory path is less confined than in the spring, with some bowhead traveling to Wrangel Island and others migrating later, following the coast of Alaska southward (Galginaitis, 2010; Quakenbush and Huntington, 2010). Their migration patterns take them past whaling communities on islands in the Bering Sea, along the coast of the Northwest Arctic Borough, and along the shore of the North Slope Borough. In the spring, Kivalina and Kiana take occasional bowheads if they follow nearshore leads, but more frequently hunt belugas, as do Noatak, Buckland, Deering, Kotzebue, and Wales (ADF&G, 2014c).

Beluga whales also migrate past NAWB communities, spending winter in the Bering Sea. In the spring, belugas migrate to coastal estuaries, bays, and rivers. The eastern Chukchi Sea stock gather in the nearshore waters of Kotzebue Sound and Kasegaluk Lagoon, near Point Lay, and Omalik Lagoon in June and July. Between July and September, females tend to remain near the Beaufort and Chukchi Seas shelf break, while the males head for deeper water. In September and October, they migrate west, returning to the Bering Sea providing additional opportunities for NWAB whalers (please see Section 3.2.4 Marine Mammals).

Spotted, bearded, ringed and ribbon seals are harvested in the communities of the NWAB. These communities are Kivalina, Noatak, Deering and Buckland. Bearded seal is the most harvested followed by spotted seal. The 2012 ice seal harvest is summarized in Table 3-16.

Table 3-16. 2012 Ice Seal (Maniilaq) Harvest Survey for Northwest Arctic Borough.

Seal Species	Deering	Noatak	Buckland	Kivalina	Total
Spotted Seal	2	22	75	20	119
Bearded Seal	42	57	42	117	258
Ringed Seal	0	2	23	15	40
Ribbon Seal	0	1	0	0	1
Loss/Killed but not Harvested	8	12	19	8	47
Totals	52	94	159	160	465

Source: North Slope Borough, 2014.

Birds and Eggs

Migratory birds and eggs have been and continue to be an important subsistence resource in the NWAB. Northwest Arctic villages are estimated to harvest 9,676 birds in 2006 and Kotzebue alone is estimated to harvest 4,437 birds in 2012. In the NWAB, Northwest Arctic villages reported harvesting 10,081 eggs in 2006, and in 2012 Kotzebue reported harvesting 2,430 eggs (Naves and Braem, 2014).

Terrestrial Mammals

Caribou is the most frequently hunted terrestrial mammal in the NWAB communities of Ambler, Buckland, Kotzebue, Kiana, and Kobuk (Table 3-17). In a 2007-2008 study season, Deering hunters harvested 182 caribou/162 pounds per person. For this community, along with the others cited here, caribou is the most prevalent resource harvested. In the 2009-2010 study season, communities harvested the following: Ambler 456 caribou/260 edible pounds per person, Buckland 561 caribou/176 per capita pounds, Kiana 448 caribou/158 pounds per capita, and Kobuk 210 caribou/194 pounds per person. The harvest area for the NWAB communities encompasses the herd range, and each community hunts at varying times throughout the year, with most communities harvest occurring primarily during August and September (Braem, 2012; Godduhn, Braem, and Kostick, 2014).

Moose is taken less frequently than caribou; however, it is still an important resource. In Deering, just over 6% of households harvested moose in 2007-2008 (Braem, 2011). In 2009-2010, Ambler took 4 moose, which equates to 9 pounds per person, Buckland took 4 moose, which equates to 10 pounds per person, Kiana took 16 moose, which equates to 22 pounds per person, and Kobuk took 8 moose, which equates to 22 pounds per person (Braem, 2012). In Kotzebue, 37.3% of the households reporting used moose, and 9.2% of the households harvested moose (Godduhn, Braem, and Kostick, 2014).

Black bear, brown bear, and muskox are also harvested by these communities. Deering harvested these resources and harvest of black bear was limited to Ambler who took four, and Kobuk who took two. The communities of Ambler, Buckland, and Kobuk harvested brown bears with the highest harvest of six brown bear in Kobuk. Buckland harvested four muskoxen in 2009-2010. A questionnaire administered by the State of Alaska Department of Fish and Game asked about two species of furbearers, wolf and wolverine, both harvested by trappers in Kotzebue (Godduhn, Braem, and Kostick, 2014).

Beavers are not harvested in Deering, but they are the most highly harvested furbearer for other communities in this region (Braem, 2011). Other furbearers harvested by Deering and other NWAB communities are wolf, lynx, wolverines, martens, and red fox.

Table 3-17. Reported Subsistence Resources in the Northwest Arctic Borough 1987-2012.

Resource	**Native Communities**										
	Kivalina	**Noatak**	**Kiana**	**Selawik**	**Kotzebue**	**Noorvik**	**Buckland**	**Kobuk**	**Deering**	**Ambler**	**Shungnak**
Marine Mammals											
Seal	X	X	X		X		X		X		
Bearded seal	X	X	X		X				X		
Ringed seal	X	X	X		X				X		
Spotted seal	X	X	X		X				X		
Ribbon seal	X				X				X		
Beluga whale	X	X	X		X		X		X		
Bowhead whale	X		X								
Polar bear	X		X		X				X		
Walrus	X	X	X		X				X		
Terrestrial Mammals											
Caribou	X	X	X	X	X	X		X	X	X	X
Moose	X	X	X	X	X	X		X	X	X	X
Brown bear	X	X	X	X	X	X		X	X	X	X
Black bear		X	X	X	X	X		X		X	X
Muskox	X	X	X								
Dall sheep	X	X	X	X	X			X		X	X
Arctic Fox (blue)	X	X	X	X				X	X	X	X
Red fox	X	X	X	X	X			X	X	X	X
Porcupine	X		X		X				X		
Ground squirrel	X			X	X			X	X	X	X
Wolverine	X	X	X	X	X	X			X	X	
Wolf	X	X	X	X	X	X			X		
Beaver	X	X	X	X	X			X	X	X	X
Land otter	X	X	X		X				X		
Marten		X	X	X	X			X		X	X
Muskrat		X	X	X	X			X	X	X	X
Fish											
Salmon	X	X	X	X	X		X	X	X	X	X
Chum		X	X	X	X			X	X	X	X
Pink (humpback)	X	X	X		X				X		
Silver (coho)	X	X	X		X				X		
Chinook	X	X	X	X	X				X		
Sockeye		X	X		X				X		
Whitefish	X	X		X	X			X		X	X
Broad whitefish				X	X	X		X		X	X
Humpback whitefish				X	X			X		X	X
Least cisco		X	X	X	X		X	X			X
Bering and Arctic cisco	X				X		X		X		

Resource	Native Communities										
	Kivalina	Noatak	Kiana	Selawik	Kotzebue	Noorvik	Buckland	Kobuk	Deering	Ambler	Shungnak
Other Freshwater Fish											
Arctic grayling	X	X	X		X			X	X	X	X
Arctic char	X	X	X		X						
Burbot (ling cod)	X	X	X		X						
Dolly Varden Trout	X	X	X	X	X		X	X	X	X	X
Lake Trout		X	X	X						X	
Northern Pike		X	X	X	X			X		X	X
Sheefish	X	X	X	X	X					X	X
Sucker				X			X	X		X	X
Mudshark/Spiny Dogfish				X			X	X		X	X
Coastal Fish											
Rainbow smelt	X		X		X	X	X		X		
Arctic cod	X				X		X		X		
Tomcod (Saffron cod)	X				X		X		X		
Herring					X				X		
Halibut			X		X						
Flounder					X		X		X		
Birds											
Snowy owl	X	X		X		X	X	X	X	X	X
Ptarmigan	X	X	X	X	X	X	X	X	X	X	X
Grouse	X	X	X	X	X	X	X	X	X	X	X
Murres	X			X		X	X	X	X	X	X
Waterfowl	X	X	X	X	X	X	X	X	X	X	X
Loon				X		X	X	X	X	X	X
Red-throated loon				X	X	X	X	X	X	X	X
Gull				X		X	X	X	X	X	X
Tundra swan	X	X	X	X	X	X	X	X		X	X
Eider	X			X	X	X	X	X	X	X	X
Common eider	X			X			X	X	X	X	X
King eider	X			X		X	X	X	X	X	X
Spectacled eider				X		X	X	X	X	X	X
Pintail	X	X		X	X	X	X	X	X	X	X
Long-tailed duck		X		X		X	X	X	X	X	X
Scoters		X		X		X	X	X	X	X	X
Bufflehead				X		X	X	X	X	X	X
Canvasback				X		X	X	X	X	X	X
Harlequin				X		X	X	X	X	X	X
Mallard	X	X		X		X	X	X	X	X	X
Merganser		X		X		X	X	X	X	X	X
Scaup				X		X	X	X	X	X	X
Teal				X		X	X	X	X	X	X
Wigeon		X		X		X	X	X	X	X	X
Other ducks	X	X	X	X	X	X	X	X	X	X	X
Geese	X	X	X	X	X	X	X	X	X	X	X
Brant	X	X	X	X	X	X	X	X	X	X	X
White-fronted goose	X	X	X	X	X	X	X	X	X	X	X
Snow goose	X	X	X	X	X		X	X	X	X	X
Canada goose	X	X	X	X	X	X	X	X	X	X	X
Sandhill crane				X		X	X	X	X	X	X
Snipe				X			X		X	X	X
Plover				X		X	X	X	X	X	X
Auk				X		X	X	X	X	X	X
Bird eggs	X	X	X	X	X	X	X	X	X	X	X
Gull eggs	X	X		X	X	X	X	X	X	X	X
Goose eggs	X	X	X	X		X	X	X	X		X

Resource	**Native Communities**										
	Kivalina	**Noatak**	**Kiana**	**Selawik**	**Kotzebue**	**Noorvik**	**Buckland**	**Kobuk**	**Deering**	**Ambler**	**Shungnak**
Duck eggs	X	X	X	X		X	X	X	X	X	X
Eider eggs	X			X		X	X	X	X	X	X
Other Resources											
Berries	X	X	X	X	X					X	X
Cranberry	X	X	X								
Salmonberry	X	X	X								
Blueberry	X	X	X	X				X		X	X
Blackberry	X	X									
Crowberry			X								
Greens/roots	X	X	X	X	X			X		X	X
Wild rhubarb	X	X	X	X				X		X	X
Wild celery	X	X		X				X		X	X
Eskimo potato	X	X	X								
Stinkweed	X	X	X								
Sourdock	X	X	X								
Willow leaves	X	X	X	X				X			X
Clams			X		X						
Crab	X	X	X		X						
Shrimp					X						

Notes: Reported Subsistence Harvest Resources in the Northwest Arctic Borough (X indicates reported use of a resource; Blank means no reported use 1987-2012).
Sources: Galginaitis (2013); Braund (2013).

Bering Strait Communities

The Bering Strait region encompasses the majority of Alaska's Seward Peninsula and the coastal lands of eastern Norton Sound and lies southwest of the Leased Area. This region is discussed since it utilizes many marine mammals which may pass through the Leased Area. This region is perhaps the most culturally diverse area in Alaska with three Native languages spoken: Iñupiaq, Siberian Yup'ik, and Central Yup'ik. Historically, areas north and west of Solomon were occupied by Iñupiat speakers, while the area to the east and south was the homeland of Yup'ik. Residents of Diomede and King Islands are Iñupiat. Saint Lawrence Island is the home of the only Siberian Yup'ik people on the American side of Bering Strait.

The ways of life and subsistence pursuits of the Bering Strait people are even more diverse than their languages: along the coast and islands of this region, residents pursue marine mammals (seal, walrus, polar bear, fish and caribou), while inland hunters and fishermen of the interior pursue caribou and fish. The region also supports large subsistence and commercial herring, salmon, and crab fisheries. The region supports 20 tribes located in 15 communities. However, for this analysis, only communities in the region utilizing the same resources as communities nearest to the Leased Area and directly adjacent to the Chukchi Sea are discussed. These communities are Shismaref, Wales, Diomede, Gambell, and Savoonga.

The communities of the Bering Sea typically subsistence hunt for bowhead whales during spring and autumn as whales migrate between the Bering and Beaufort seas (Suydam and George, 2013). Hunters in the communities of Gambell and Savoonga on St. Lawrence Island in the northern Bering Sea may harvest whales during the winter (i.e., December and January) as well. In 2014, Bering Strait subsistence hunters, in cooperation with the Alaska Native Tribal Health Consortium, expected to collect specimens from subsistence mammals to test for metal contaminants like mercury, human-made contaminants like poly-chlorinated biphenyls (PCBs), and antibodies to pathogens an animal has previously been exposed to, and will determine possible widespread threats to food security and human health (ANTHC, 2014). Table 3-18 lists subsistence resources utilized by Bering Strait communities from 1987-2013.

Table 3-18. Bering Strait Community Subsistence Use Resources 1987-2012.

Resource	Wales	Diomede	Gambell	Savoonga	Shishmaref
Marine Mammals					
Bearded seal	X	X	X	X	X
Ringed seal	X	X	X	X	X
Spotted seal	X		X	X	X
Ribbon seal	X		X	X	X
Beluga whale	X	X	X	X	X
Bowhead whale	X	X	X	X	X
Polar bear	X	X	X	X	X
Walrus	X	X	X	X	X
Terrestrial Mammals					
Caribou	X	X	X	X	X
Moose		X	X	X	X
Brown bear	X		X	X	X
Dall sheep		X	X	X	X
Muskox			X		X
Arctic fox (blue)	X		X	X	X
Red fox	X		X	X	X
Porcupine			X	X	
Ground squirrel	X		X	X	X
Wolverine	X		X	X	X
Weasel			X		X
Wolf	X		X	X	X
Marmot	X		X		X
Fish					
Salmon	X	X	X	X	X
Chum	X	X	X	X	X
Pink (humpback)		X	X	X	X
Silver (coho)		X			
Whitefish		X	X	X	X
Round whitefish			X	X	
Humpback whitefish			X	X	X
Least cisco			X	X	X
Bering and Arctic cisco	X		X	X	X
Other Freshwater Fish					
Arctic grayling	X	X	X	X	X
Arctic char	X	X	X	X	X
Burbot (ling cod)			X	X	X
Lake trout			X	X	X
Northern pike			X	X	
Broad whitefish			X	X	X
Other coastal fish					
Rainbow smelt	X		X	X	
Arctic cod			X	X	X
Tomcod	X	X	X	X	X
Flounder		X			
Birds					
Snowy owl		X	X		
Red-throated loon	X		X	X	
Tundra swan			X		X
Eider		X			
Common eider	X		X	X	X
King eider	X		X	X	X
Spectacled eider	X		X	X	
Steller's eider	X		X	X	
Other ducks		X	X	X	X
Pintail	X		X		X

Resource	Wales	Diomede	Gambell	Savoonga	Shishmaref
Long-tailed duck	X		X	X	X
Surf scoter			X	X	
Geese		X			
Brant	X	X	X	X	X
White-fronted goose	X		X	X	X
Snow goose	X		X	X	X
Canada goose	X		X	X	X
Ptarmigan			X	X	X
Willow ptarmigan	X		X	X	
Other Resources					
Berries	X	X	X	X	X
Cranberry			X	X	
Salmonberry			X	X	
Bird eggs	X	X	X	X	X
Gull eggs			X		X
Goose eggs			X		X
Eider eggs			X	X	X
Greens/roots			X	X	X
Wild rhubarb			X	X	
Wild chives			X	X	
Clams			X	X	
Crab	X	X	X		X

Notes: Reported Subsistence Use Resources in Bering Strait Communities (X indicates reported use of a resource; Blank means no reported use 1987-2012)

Sources: Galginaitis, 2013; Braund, 2013; BOEM, 2012; ADF&G, 2014c.

Russian Coastal Communities

The Chukotka Autonomous Okrug is the only place in Russia where traditional whaling is a point of special importance. Chukotka is one of the farthest and out-of-the-way territories of the Russian Far East. At least five indigenous ethnic groups live in this region: the Coastal and Inland Chukchi, Yupik Inuit, the Even, the Chuvantsi, and the Yukagir. Native residents of coastal settlements of Bering, Chukchi and East-Siberian seas are inseparably linked with the sea, and particularly, with whaling and sealing. At the present time, traditional whaling occurs in over 20 communities and settlements of the Chukotka (Borodin et al., 2012). This traditional dependence dates back thousands of years and still ensures survival of people in this subpolar area. The very process of hunting for gray whales and further use of whale products in life are essential for preserving culture and spirit of aboriginal population of Chukotka. Gray whales are an all-purpose subsistence resource for the people of Chukotka, because all edible parts of these cetaceans are included in diet, while inedible parts are totally used in household. Meat, organ meat and fat are used as food, whale bones and baleen are used to make various types of equipment, and parts of marine kayaks, skin of marine mammals is used in clothes and boots, belts and covering of kayaks. Hence, any whale product may find an application in either the material or spiritual life of Chukotka indigenous people. Traditional hunting for marine mammals is based on the culture's principle of rational use and waste-free consumption. Whale harvests define the social, cultural, and economic structure of Chukotka's coastal communities and play a key role in traditional relationships between reindeer herding families and maritime hunters. Therefore, traditional whaling is an integral part of existence of Chukotka's Native people, both from the point of physical survival and from the point of cultural continuity, defining the uniqueness and originality of these people. Table 3-19 summarizes the most harvested subsistence resources of the Russian Chukotka Peninsula.

According to Ainana, Zelensky, and Bychkov (2001), the Native residents of this area (Eskimo and Chukchi) made up over 60% of the population of the Chukotka Peninsula. There has been a redistribution of Native people among the communities, with the proportion of Natives in the regional centers, Provideniya and Lavrentiya, constantly growing. This growth is in part because large communities attract residents of smaller Native communities because they have a better chance of finding permanent work there, or even temporary earnings. Residents remaining in Native coastal communities engage in subsistence activities focused on marine mammal hunting, reindeer herding, hunting and trapping, fishing, and gathering. Subsistence resources harvested include (Ainana, Zelensky, and Bychkov, 2001):

Table 3-19. Most Harvested Russian Chukotka Subsistence Resources.

Russian Chukotka Subsistence Resources	
Resource	**Types**
Whales	Gray (preferred species), Bowhead, and Beluga
Seals	Bearded, Ringed, and Spotted seal
Walrus	N/A
Marine invertebrates	Shellfish, Mollusks
Kelp	Various species
Furbearers	Snowshoe hares, Red and Arctic fox, Wolves, Wolverines
Birds	Common eider, Steller's eider, King eider, Spectacled eider, Long-tail duck, Pintail and Harlequin ducks, Brant and Emperor geese
Eggs	Cormorant, Gull, Eider, Murre
Fish	Pink, Chum, Coho, and Sockeye salmon, Arctic and Saffron cod, Arctic char, Grayling, Dolly Varden, Flounder, Smelt, Sculpin
Plants and Berries	Various species

Source: Ainana, Zelensky, and Bychkov, 2001

Harvest seasons for the Russian Chukotkan Region have been defined differently than as previously defined for Alaska Native Communities in this discussion. This is due to research conducted by Ainana, Zelensky, and Bychkov (2001). These seasons are identified by this research as occurring in:

- Autumn (September, October, November)

  This is the walrus hunting season and also includes harvests of gray and beluga whales, bearded seal and ringed seal, migrating birds - eiders of different species, long-tailed duck, pintail, emperor goose, and brant, fish, plants, edible roots, and berries (crowberry and lingonberry). Marine mollusks and kelp are gathered when they are washed onshore by storm waves.

- Winter (December, January, February)

  Weather and ice conditions permitting, hunters go out for small seals at the edge of the landfast ice. Subsistence harvests include hunting for snowshoe hares and ptarmigan. Winter is the peak ice fishing season for arctic cod, cod, saffron cod, and Arctic char.

- Spring (March, April, May)

  April is oftentimes called the "hungry month" since by this time people have more or less depleted their winter stores of food (Ainana, Zelensky, and Bychkov, 2001) and in May, with the arrival of the birds, game bird becomes a quickly harvested resource. While there is still ice along the coastline, people catch Arctic cod, saffron cod, and cod, and arctic char in rivers and lakes. During this time, residents eagerly await spring migration northward of walrus and seals.

- Summer (June, July, August)

  Harvesting of marine mammals (gray whale) and seals usually occurs during these months. Early in this season, a short harvest season for birds' eggs occurs. Summer is also the time when salmon comes inshore and is an important time for coastal residents who catch chum, pink, sockeye, and coho salmon. Edible greenery growing on land is actively gathered during this season.

Table 3-20 shows that in 1999 the largest number of gray whales was harvested by hunters from Lorino (63) and Lavrentiya (12), which together had the highest Native population at that time (2,500 out of a total of nearly 4,000 Native people). From 1998 to the present time, average annual takes of gray whales has numbered approximately 120, a 28% decline compared to the years 1960-1990 where the annual take numbers were 160-170 annually (Borodin et al., 2012). The severe climate of Chukotka defines very specific needs in nutrition for indigenous people. Replacement of gray and bowhead whale products by any other food is impossible due to many social, cultural, psychological, and physiological reasons. Substitution of bowhead whale meat for that of gray whales is also unfeasible for residents of Chukokta, because their tastes differ, these animals are available for hunt at different times, and their cultural value for Native people is not comparable to the gray whale (Borodin et al., 2012). However, even though bowhead whales are not preferred, the Russian Federation is given a quota by the IWC of seven bowhead whale strikes annually.

Table 3-20. Official Whaling Statistics for the Chukotka Peninsula in 1999.

Community	Whales Harvested
Neshakn, Enurmino	4 gray
Inchoun, Uelen	20 gray
Inchoun	3 gray
Lavrentiya	12 gray
Lorino, Akkani hunters camp	63 gray, 1 bowhead
Yanrakynnot	4 gray
New Chaplino	4 gray
Sireniki	5 gray
Nunligran	2 gray
Enmelen	2 gray

Source: Chukotka Regional Fisheries Inspection Authority as cited by Ainana, Zelensky, and Bychkov (2001).

3.3.3. Sociocultural Systems

Sociocultural systems encompass the social organization and cultural values of a society (Tudge, Shanahan, and Valsiner, 2008). This section discusses present sociocultural systems of the NSB, NWAB, Bering Strait region, and Russian Chukotka region as the umbrella for analyzing cause-and-effect relationships among different variables (political, social, cultural), as well as concepts underlying the "sociocultural system" milieu (subsistence resources and practices, community health, and environmental justice). This discussion of sociocultural systems identifies the interaction among variables affecting the political, social, and cultural values of communities to be analyzed and to provide a brief explanation for similarities among communities in the Leased Area. Some of these variables are:

- Political organization and structure
- Relationships between cultural values, including kinship, ties, the family, the community, and subsistence practices
- Demographic conditions
- Interaction between the environment and subsistence practices
- The integration of subsistence and economic systems of these larger all-encompassing sociocultural systems

As stated above, sociocultural systems encompass the social organization and cultural values of a society. A primary focus in this discussion is on communities that might be affected by activities in the Leased Area. Populations and general demographics of these communities are discussed in Section 3.3.2.

The communities of Barrow, Wainwright, Point Lay, Point Hope, and Atqasuk are within the NSB and are located closest to the Leased Area. The ethnic, sociocultural, and socioeconomic makeup of these communities is primarily Iñupiat (Section 3.3.2, Table 3-13). Sociocultural systems and the structure of social organizations including cultural values were discussed previously in the 2007 FEIS (Section III.C.3) and the 2011 SEIS (Section III.C.3). However, new information since the 2007 FEIS and the 2011 SEIS will be considered, and a discussion of several additional communities provided. These additional communities considered outside the Leased Area are communities located in the NWAB, Bering Strait region, and the Russian Chukotka region and, although not directly adjacent to the Leased Area, these communities are culturally similar to communities closest to the Leased Area, share many of the same resources, and have the potential to share similar effects from OCS oil and gas development.

Because the Leased Area is, for the most part, located closest to communities largely inhabited by Iñupiat, Alaska Native sociocultural systems and the maintenance of cultural values and traditions with respect to social organizations are important issues to consider. Alaska Native communities are governed internally and during previous oil and gas development projects, have largely been isolated from enclaves of transient oil and gas workers. Some Alaska Natives are employed in the oil and gas industry, yet many remain culturally and economically reliant on subsistence hunting and fishing. Among the most prized values retained are those of social cohesion and group activities expressed through subsistence harvesting of resources. Alaska Natives have been able to maintain these values partly because of the interaction between ecological possibilities, history of contact with non-Natives, and a strong commitment to retaining their culture and identity. The sociocultural systems of modern Alaska Natives have been modified to some extent from those existing prior to Euro-American contact; however, much of the earlier systems survive, resulting in modern sociocultural systems that to various degrees blend traditional and Euro-American characteristics.

Native populations in Alaska are involved in a complex network of institutions, unique to other Native American populations in the United States. These unique institutions have allowed Alaska Natives to retain or regain control over much of their traditional homelands and modify western institutions of government and business to further traditional values. These include municipal governments, tribal councils, regional and village Alaska Native Claims Settlement Act (ANCSA) corporations, regional corporations, and non-governmental organizations (NGOs) such as the Alaska Federation of Natives (AFN) and the Alaska Eskimo Whaling Commission (AEWC). Under the Alaska Native Claims Settlement Act (ANCSA), titles to land were given to 12 regional for-profit corporations and more than 200 village corporations that could be organized on either a not-for-profit or for-profit basis with corporation shares divided among Alaska Natives. In most cases, village corporations hold title to the surface estate, while regional corporations hold title to the subsurface estate. Despite initial concerns that Native cultural values would be enveloped by American corporate culture and that they could eventually lose control of their corporations and corporation lands, Alaska Natives have modified corporate culture to support traditional cultural values including sharing and subsistence (ASRC, 2014). Given these multiple layers of jurisdiction and control, a Native community might be governed by a local municipal government, a wider borough government, and a local and regional tribal council. The land surface might be owned and administered by a village corporation while subsurface resources would be under the control of a regional corporation.

Iñupiat culture has strong ties to the natural environment. Traditional activities are central to their historic and contemporary ways of life, with subsistence seasons focusing specific activities. Family, kinship relationships, and teaching youth traditional practices are strong influences on contemporary life and shape social interactions. 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. The North Slope Borough identifies and promotes twelve Iñupiat values in the communities (NSB, 2014a). These are:

- Avoidance of Conflict – PAAQLATAUTAIŃŃIQ
- Compassion – NAGLIKTUUTIQAĠŃIQ
- Cooperation – PAAMMAAĠIIŇIQ
- Family and Kinship – ILAGIIGŇIQ
- Sharing - AVIKTUAQATRIGIIGŇIQ
- Respect for Nature – QIKSIKSRAUTIQAĠNIQ IŇUUNIAĠVIGMUN
- Humility – QIŇUIŇŇIQ
- Humor – QUVIANĠUNIQ
- Hunting Traditions – AŅUNIALLANIQ
- Knowledge of our Language – IŇUPIURAALLANIQ
- Spirituality – UKPIQQUTIQAĠNIQ
- Love and Respect for Our Elders and One Another – PIQPAKKUTIQAĠNIQ SULI QIKSIKSRAUTIQAĠNIQ UTUQQANAANUN ALLANULLU

In keeping with these stated Iñupiat values, it is important to listen to Alaska Native community residents' 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 U.S. Chukchi Sea coastal communities have been consistent about their concerns during the more than 20 years of public hearings and meetings on State and Federal oil development on the North Slope. Cultural concerns cited during that time include:

- Effects from oil spills on subsistence activities and any long lasting effects on the Iñupiat people in terms of subsistence activities
- A general fear of cultural change, especially in terms of the loss of a subsistence way of life, 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 document reviews

In Alaska Native communities "institutional organizations" are comprised of government and nongovernment entities that provide services to the community. Governmental organizations that make up the institutional organization of the region closest to the Leased Area include the NSB, city governments, Tribal governments, Alaska Native Regional, and Village corporations. Nongovernmental entities that work in conjunction with governmental organizations include nonprofit corporations and organizations such as the AEWC and others that play important roles in the management of resources vital to the subsistence and cultural needs of the communities.

Each of the U.S. Chukchi Sea coastal communities except Point Lay has a city government. While certain municipal powers were turned over to the NSB, community governments play an important role in the administration of NSB programs and representing community interests. Federally recognized tribal governments in all U.S. Chukchi Sea communities are active in community government and provide services to tribal members.

Sociocultural systems of Alaska Iñupiat communities are analyzed and described in detail in the Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017 Final Programmatic Environmental Impact Statement (USDOI, BOEM, 2012), National Petroleum Reserve in Alaska

Final Integrated Activity Plan/EIS (USDOI, BLM, 2012), 2011 SEIS (Section III.C.3), and the 2007 FEIS (Section III.C.3).

In Russia, Native populations of Chukotka were subjected to losses of culture and community during the 20th century, resulting from the large-scale, state- induced closures of many Native communities and the subsequent resettlement of the population to centralized communities following collapse of the Soviet economy and its infrastructure. Voluntary abandonment, and state-induced or forced resettlements of Native communities in the 20th century have drastically reduced the inhabited sites along the Bering and Chukchi Sea coast.

The Sovietization of the Russian North and the corresponding community relocations in Chukotka led to a collision of theories and practices. A Soviet spatial logic was implanted on traditional harvest use areas and on hunting and gathering of Native sea mammals and terrestrial resources. In Chukotka, where Native coastal settlements were located close to preferred subsistence sites, maximum access to subsistence resources, like sea mammal migration routes, salmon runs, plant gathering sites, and even drinking water had been traditionally key in choosing optimal sites for settling communities. The Soviet era brought a diametrically opposed spatial logic to the region. For Soviet economic planners and engineers, maximum infrastructural access to communities and state enterprises was one of the prime motivators for concentration of Native populations in centralized communities (Holzlehner, 2014).

The socio-cultural fabric of Native communities was impacted by traumatic losses of Native homelands and vanishing of the socio-economic structures that had replaced traditional ways. Relocations in Chukotka had long-term effects on traditional culture and individual lives. Some of the relocations were executed in such a hasty manner that most of the household items had to be left behind. In the majority of the cases, the host communities were not prepared for the influx of dozens of families, and these new sites were inferior in terms of hunting possibilities. Many hunters had to forfeit their profession for work in state collective farms. All of this created a loss of language, cultural expressions, and hunting grounds, exaggerated by unfamiliar living conditions in the new communities.

Although the community relocations often had devastating results on Native culture, many of the ruins of former Soviet settlements now play a role in present-day lives. Many individuals are moving back into the formerly abandoned communities and actively use these sites for a variety of subsistence activities. Embedded in the landscape and local ecology, these reoccupied sites allow for some people to escape the historic attempts at Soviet modernization. The topography and ecology of these communities, which are exclusively located on bluffs or small cliffs near sea mammal migration routes, and from which walruses and whales can be easily spotted by hunters, combined with a desire to flee the larger communities and their intrinsic problems make them attractive places to live, and they hold distinct cultural qualities (Holzlehner, 2014).

Chukotka Natives who are revitalizing old hunting technologies, subsistence camps, and traditional forms of cooperation, are allowing for traditional life ways that are diametrically opposite to the ones in the more ‘urban’ communities. For example, hunting camps are “dry,” and traditional hunting and butchering technologies are actively passed on to younger generations.

This revitalization of traditional cultural values and the resettlement of former Native communities have given rise to new cultural possibilities. In these rural Native communities, access to gasoline is a key asset. This underscores the essential role of fuel in hunting communities across the circumpolar North including Alaska (Holzlehner, 2014).

Governance of the Russian Chukotka communities is primarily regional. Anadyr, a port town located on the Gulf of Anadyr, serves the Chukchi Peninsula and is the seat of regional government for the Chukotka Autonomous Region. Locally, this region is divided into several districts which govern larger communities with a municipal division. Some districts are incorporated as a municipal district, such as Providensky Municipal District (including the communities of New Chaplino, Yanrakynnou, Sireniki, Enmelen, and Nunligran). These municipal districts are further divided into one urban settlement and three rural settlements. Many of the communities that share the Chukchi Sea coast are located in the Chukotka Municipal District or the Iultinsky Municipal District (includes eight municipal settlements; two urban- Egvekinot and Mys Shmidta; and six rural- Amguema, Vankarem, Konergino, Nutepelmen, Ryrkaipiy, Uelkal) (State of Chukotka, 2014).

3.3.4. Public and Community Health

A few examples of community concerns related to oil and gas projects have been:

- Effects of a large spill on biological resources, human health, and cultural well-being of communities that depend upon subsistence resources
- Conditions posing unreasonable risks to public health
- Oil spills

Health, as defined in 1948 by the World Health Organization (WHO) is a “state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.” Community health is defined by Green and McKenzie (2014), as the health status of a defined group of people, or community, and the actions and conditions that protect and improve the health of the community.” Individuals who make up a community are those that live in a localized regional area, and are governed under the same general regulations, norms, values, and organizations.

The availability of resources, such as subsistence resources, can influence population health outcomes. Health includes both social and physical determinants.

Some examples of social determinants include (USDHHS, 2014):

- Availability of resources to meet daily needs, including availability of subsistence foods
- Social norms, attitudes, and support
- Cultural and language literacy
- Socioeconomic conditions, including poverty
- Availability of community-based resources in support of community living and opportunities for various activities
- Access to economic and job opportunities
- Quality of education and job training
- Access to health care services and public safety
- Transportation options

Some examples of physical determinants include (USDHHS, 2014):

- Natural environment, such as subsistence use areas or weather (e.g., climate change)
- Infrastructure, such as buildings, boardwalks, and roads
- Housing and community design (e.g., running water, plumbing)
- Exposure to toxic substances and other physical hazards
- Physical barriers, especially for people with disabilities

To determine the overall health of a community, both health determinant data (social and physical) and health outcome data (life expectancy, health conditions, etc.) are used to establish the baseline health status of a community. Health determinants associated with positive and negative outcomes can be family structure, economic status, educational attainment, family stability, and cultural continuity. Health outcomes are used as general indicators of physical and social wellness. These outcomes include life expectancy, chronic health conditions dietary diseases (obesity, diabetes), and cultural or traditional well-being.

Economics can also be a health determinant. The U.S. Census Bureau collects data on median household income via the American Communities Survey (ACS income includes all monetary sources of income including wages, the Alaska Permanent Fund Dividend, Corporation Dividends and Public Assistance (DCRA, 2014)).See Section 3.3.1, Economy, for additional background information. The oil and gas industry is a major economic driver in the NSB and jobs provided can also affect income and health status of these communities (NSB, 2014b).

A discussion of health determinants and outcomes is included in the 2007 FEIS (Section IV.C.1.p(2)(d)). This discussion recognizes that much work has been conducted into identifying "social determinants of health" which are the reproducible association between an array of socioeconomic and environmental factors (many which have been studied individually) and specific health diagnosis.

Health Determinants and Outcomes

The North Slope Borough (2014) conducted a health indicator study which monitored the effects of resource development projects. The conclusion reached by this study was that both determinants of health and health outcomes are changing for better (decreasing infant mortality rates) and for worse (higher rates of diabetes and obesity). However, some health trends from this study remained constant (unintentional injury and medevac transports per year).

Food Environment and Security

Health benefits associated with harvesting traditional food play an important role in the overall health and well-being of residents of the North Slope. In many cases, communities are shifting away from a traditional diet toward a diet of processed foods. In general, Iñupiaq living on the North Slope tend to take a holistic view of health and well-being with traditional foods being a cultural anchor. Traditional foods can provide the following health benefits (Watt-Cloutier, 2003; Van Oostdam et al., 2005):

- The sharing of traditional food plays a role in the maintenance of social norms
- Given the high cost of living in most Arctic communities, traditional food can save families money
- There are important spiritual aspects associated with traditional food use
- Traditional foods provide substantial nutritional benefits
- There are many physical health benefits associated with harvesting traditional food
- Sharing of food and material wealth is a cultural value ensuring that families or individuals are provided for in times of need. The exchange of subsistence foods within a community is an important element of social well-being and is intrinsic to local culture (AMAP, 2009).

It has been shown that traditional foods were found to contribute 15% of dietary energy and to contribute disproportionately more protein, total fat, monounsaturated fat, polyunsaturated fat, n-3 fatty acids, vitamin B12, and iron. Younger adults who consumed even less traditional food (10% to 13% energy) still obtained 16% to 64% of these same nutrients from traditional food. Seal oil and salmon were shown to be the main sources of n-3 fatty acids for all individuals eating traditional foods. The proportion of fat increased and the proportion of carbohydrate intake decreased as age increased (Nobmann et al., 2005). Around 69% of traditional food energy intake was from marine sources (fish and seal oil) (Bersamin et al., 2007).

Food security is "the assurance that all people at all times have both physical and economic access to food they need for an active, healthy life. It means that the food itself is safe, nutritionally adequate and culturally appropriate and that this food be obtained in a way that upholds basic human dignity" (WHO, 2006). Food security is based on three basic components: food availability (i.e., sufficient quantities of food available on a consistent basis), food access (i.e., having sufficient resources or income to obtain appropriate foods for a nutritious diet), and food use (i.e., appropriate use based on knowledge of basic nutrition and care) (WHO, 2006). Other concepts that are beginning to be included in discussion on food security are the risks of climatic fluctuations, conflicts, job loss, and disease, all of which can disrupt any of the first three factors (Webb et al., 2006).

Food security on the North Slope involves unique, more complex issues than food security in sub-Arctic populations or in populations with differing storage methods. North Slope communities rely heavily on traditional food, which plays a critical role in health, and the procurement and consumption of traditional food is important for maintaining cultural values, identity, good health, and social well-being (Chan, 2006). In many communities, traditional foods are also an economic necessity. Concerns about contamination of traditional food include toxin exposure and possibly impacts to the cultural way of life (Kuhnlein, 1995). Factors which can also affect food security include: poverty and unemployment, changes in food sharing networks, environmental contamination, climate change, thawing of permafrost food storage areas, access to subsistence hunting lands, loss of traditional knowledge, and readily available processed foods in communities (Power, 2007; Bersamin, 2007).

Traditional Culture and Well-Being

Cultural well-being for individuals harvesting traditional subsistence foods plays an important role in the overall health and well-being of communities (AMAP, 2009).

Traditional culture has been strongly tied to health in the Native communities of Alaska and elsewhere (Curtis, Kvernmo, and Bjerregard, 2005; Smylie, 2009). Language, respect for elders, participation in subsistence activities, and family stability are cultural traditions that remain strong. Iñupiaq language is spoken in the communities of Barrow, Nuiqsut, and Wainwright, and is an important cultural value; but in the entire NSB, Iñupiaq fluency is only 18.2%, with limited proficiency of the language reported at 32% (NSB, 2010). CDC Snap Shots of State Population Data (SNAPS) indicate that grandparents as caregivers numbered 227 in the communities of the NSB (CDC, 2007). The 2014 NSB health indicator study collected household opinions about respect for elders. It found elders are identified as "highly respected," reported at a range in households from 80% to a little less than 60%. Participation in subsistence activities in the NSB still remain major part of the cultural fabric of the community with individuals reporting participation in subsistence activities ranging from between 25- 40% participation (NSB, 2014b). Family stability has traditionally been assessed according to factors related to family structure, such as single parenthood. One measure of family stability is the divorce rate. The Alaska Bureau of Vital Statistics maintains a database on divorce for the state and boroughs (ADHSS, BVS, 2012). Divorce rates for females and males in the North Slope Borough show lower rates of divorce than in the State of Alaska, indicating possibly greater family stability in this region. In the NSB, 2009 divorce rates for females was 4.5 per 1,000 and for males it was 3.1 per 1,000. Divorce rates in the State of Alaska were 8.1 for females and 7.5 per 1,000 for males respectively (NewFields, 2012).

Using single parenthood as another marker of family stability, the North Slope Borough and all of the communities in this region have a higher percentage of households headed by females without husbands than the State of Alaska. In Nuiqsut, almost 35% of households are headed by females only, more than twice the statewide percentage. This indicator would suggest decreased family stability in the region; however, when considering other markers of family stability such as divorce, the statistics may not be conclusive.

Municipal Infrastructure

Law enforcement and other services such as water, solid waste disposal, emergency services, and heating are essential infrastructure services for all NSB residents. There is considerable variation for these services between communities. One infrastructure item of great importance is water supply. Most communities rely on a surface water source with a water treatment system, and all communities in this region use a combination of piped and trucked water. A majority of houses in most communities have municipal sewage facilities, with 10% using holding tanks. A substantial portion of residents rely on outhouses. In many rural Alaskan communities the cost of water is a health and economic issue that leads to household water rationing.

Health Care Services

Health care services in NSB communities are comprised of health clinics staffed by Community Health Aides as well as the Samuel Simmonds Memorial Hospital in Barrow which was built in 2010 and the Maniilaq Health clinic in Kotzebue, rebuilt in 1994. According to the NSB (2014), resource development projects have the potential to increase demand on local health care services, due to in-migration of workers or by increasing burden of disease. Resource development can also improve availability of health care services by providing funding through tax revenue. In 2013, the total number of patient visits to health clinics and the Samuel Simmonds Memorial Hospital for the year was: Barrow 81,468; Wainwright 9,610; Point Lay 3,716; Atqasuk 4,483; Nuiqsut 7,862; and Kaktovik 5,130. Since Barrow is home to the only hospital in the NSB, it has the highest number of patient visits of all the communities. The Maniilaq Health Center is the primary health care facility for all residents of the Northwest Arctic Borough, plus Point Hope (NANA, 2010).

Environmental Contaminants

While a release of contaminants to the environment may occur from resource development activities, the presence of a contaminant does not immediately mean there will be health effects (NSB, 2014b). Exposure can occur through a number of different routes. These include inhalation (via outdoor or indoor air; ingestion (through food or water); or via dermal contact (touching a substance) (NSB, 2014b).

Climate Change and Community Health

Climate change is affecting the lives of Alaska Natives. A changing climate forces people to behave in new ways and with new adaptive cultural mechanisms (Berner and Furgal, 2005; Warren, Berner, and Curtis, 2005).

3.3.5. Environmental Justice

“Environmental justice” (EJ) is an initiative that culminated with the February 11, 1994, Executive Order (EO)12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,” and an accompanying Presidential memorandum. The EO requires that each Federal agency consider environmental justice to be part of its mission. Its intent is to promote fair treatment of people of all races and income levels, so no person or group of people bears a disproportionate share of the negative effects from the country’s domestic and foreign programs.

Specific to the EIS process, the EO requires that proposed projects be evaluated for “disproportionately high adverse human health and environmental effects on minority populations and low income populations” and guidelines in EO 12898 require that each Federal agency:

- Consider environmental justice to be part of its mission
- Provide an evaluation in an EIS or EA as to whether the Proposed Action would have “disproportionately high adverse human health and environmental effects on minority populations and low income populations.”

Several minority and low-income populations might be affected by implementation of the Proposed Action or alternatives. Demographic information on ethnicity, race, and economic status is provided in Section 3.3.2 as the baseline against which potential effects can be identified and analyzed.

The CEQ identifies groups as low income or minority populations when either:

- The minority or low-income population of the affected area exceeds 50%
- The minority or low-income population percentage in the affected area is meaningfully greater than the minority population percentage in the general population or appropriate unit of geographical analysis.

In order to be classified meaningfully greater, a formula describes an environmental justice threshold of 10% above the State of Alaska percentage of for local minority (above 39.5%) and low-income persons (above 10.5%). For purposes of this section, minority and low-income populations are defined as follows:

- Minority populations are persons of Hispanic or Latino origin of any race, Blacks or African Americans, American Indians or Alaska Natives, Asians, and Native Hawaiian and other Pacific Islanders as reported in the 2010 U.S. Census
- Low-income populations are persons living below the poverty level as reported by the American Community Survey for 2006-2010

Alaska Iñupiat Natives—residents of the communities of the NSB and the NWAB—are a recognized minority group. The ethnic compositions of Barrow, Wainwright, Point Lay, Point Hope, and Atqasuk, are shown in Table 3-13 and meet the 50% population threshold which classifies them as EJ Communities on the basis of their proportional American Indian and Alaska Native membership (Norris, Vines, and Hoeffel, 2012). Other communities that meet the 50% population threshold are the NWAB communities identified in the subsistence section, above (Kotzebue, Kivalina, Ambler, Deering Buckland, Noatak, Kiana, Selawik, Noorvik, Kobuk, and Shungnak).

The geographic distribution of minority and low-income groups in the affected area, based on the 2010 U.S. Census demographic data and the following definitions of minority and low-income population groups is described throughout section 3.3 and analyzed in Chapter 4:

Minority - Persons are included in the minority category if they identify themselves as belonging to American Indian or Alaska Native and persons who classify themselves as being of multiple racial origin, including Alaska Native, may be counted.

Low-Income – Low-income individuals are those who fall below the poverty line. The poverty line takes into account family size and age of individuals in the family. In 2014, poverty level for 2014 was set at $23,850 (total yearly income) for a family of four (USDHHS, 2014). For any family below the poverty line, all family members are considered as being below the poverty line for the purposes of analysis.

All North Slope communities have predominantly Iñupiat population and low incomes are seen primarily in Native subsistence-based communities (Section 3.3.2, Table 3-13).

Alaska Natives are the only minority population allowed by law to hunt for marine mammals in the U.S. Chukchi Sea region. There are not substantial numbers of “other” minorities in potentially affected communities and for centuries, Iñupiat survival in the Arctic has centered on harvesting of subsistence foods, materials, and passing on knowledge to harvest these resources. Iñupiat culture has depended upon passing on traditional knowledge and beliefs about subsistence resources including:

- Observations of game behavior to successfully locate and harvest game
- Hunter and family behaviors to ensure successful harvests in the future (Spencer, 1976)

Further discussion of general EJ issues in the Leased Area and concerns related by communities can be found in the 2007 FEIS (Section III.C.6) and in the 2011 SEIS (Section III.C.5).

Responses to the call for Information and Nominations for the Chukchi Sea OCS Oil and Gas Lease Sale 237 (78 *FR* 59715, September 27, 2013) included concerns voiced by the NSB and NWAB regarding EJ-related issues:

- Assessment of areas important to subsistence use
- Climate change and changing bowhead whale hunting practices
- Deflection of subsistence resources by noise and development
- Mitigation measures to protect subsistence practices and bowhead whale health
- Concerns related to Arctic food security issues and human health
- Vessel transits and effects on bowhead whales and subsistence activities
- Discharges near areas where food is taken or eaten directly from the water
- Impacts of oil spills and oil-spill responses on resources, subsistence activities, and Iñupiat physical and cultural well-being, and
- Concerns related to increasing scientific and traditional knowledge as they inter-relate when analyzing sensitive habitats having multiple uses

3.3.6. Archaeological Resources

Archaeological Resources can be defined as “any prehistoric or historic district, site, building, structure, or object [including shipwrecks]…Such term includes artifacts, records, and remains which are related to such a district, site, building, structure, or object” (National Historic Preservation Act, Sec. 301(5) as amended, 16 USC 470W(5)). Significant archaeological resources are either historic or prehistoric and generally include properties that are 50 years old or older that (1) are associated with events that have made a significant contribution to the broad patterns of our history; (2) are associated with the lives of persons significant in the past; (3) embody the distinctive characteristics of a type, period, or method of construction; (4) represent the work of a master; (5) possess high artistic values; (6) present a significant and distinguishable entity whose components may lack individual distinction; or (7) have yielded, or may be likely to yield, information important in history. These resources represent the remains of the material culture of past generations of the region’s prehistoric and historic inhabitants. They are basic to our understanding of the knowledge, beliefs, art, customs, property systems, and other aspects of the nonmaterial culture.

Offshore Archaeological Resources

Archaeological sites on the Arctic OCS can be divided into two discrete types: (a) vessel wrecks, both shipwrecks and air plane wrecks, and any remains associated with them; and (b) submerged landscapes and prehistoric sites that may have been buried when the Land Bridge (Beringia) was exposed or inundated by rising sea levels at the end of the Ice Age (Pleistocene). BOEM has compiled the most comprehensive vessel wreck database in waters offshore of Alaska that exists. BOEM also compiled a geodatabase of Chukchi landforms that might be representative of archaeological sites through 1990. Shipwrecks are likely to have survived in the Leased Area, especially those that may be at a depth beyond intensive ice gouging (Tornfelt, 1982; Tornfelt and Burwell, 1992). Between 1861 and 1950, historic accounts have identified 83 shipwrecks occurring either onshore or offshore within the Chukchi Sea Planning Area. Two potential shipwreck locations have been identified in the Leased Area (see the 2007 FEIS (Map 7)). In a 12-day period in September 1871, nearshore from Kuk Inlet north to Point Franklin and the Seahorse Islands, 32 whaling ships were crushed in the ice. Other whalers were lost in other incidents off Point Hope, Icy Cape, Point Franklin, and Barrow. No surveys of these shipwrecks have been made; therefore, no exact locations are known. The possibility exists that a number of these shipwrecks have not been completely destroyed by ice movement and storms. The probabilities for preservation are particularly high around Point Hope, Point Belcher, Point Franklin and Point Barrow. With some exceptions, the sites of most of these shipwrecks are within State waters; however, the best preserved shipwrecks are likely to be found on the OCS because wave action and ice are less likely to contribute to the breakup of ships in deeper waters. It is not possible to tell which, if any, erosional processes have destroyed archaeological resources in the Leased Area until surveys have been conducted and interpreted (Tornfelt and Burwell, 1992; USDOI, BOEM, 2014b Table III.C.18).

In 1998, the first scientific survey of the whaling wrecks off Wainwright was undertaken. Its mission was to locate the sunken New Bedford whaling fleet of 1871, believed to be located in approximately 25-52 ft (7.6-15.8 m) of water off Point Belcher. Dubbed the Jeremy Project, the survey was made up of scientists from NASA, BOEM (then MMS), Ames Research Center, and Santa Clara University in California. The team worked from late August to early September during the open-water season with the help of the U.S. Coast Guard, the icebreaker POLAR STAR, and the U.S. Navy.

State-of-the-art equipment, originally developed by NASA's Ames Research Center for the Mars Pathfinder Project, was used to search for the wrecks. The team used Mars Pathfinder mapping programs, originally designed to map and analyze geological features of dry, planetary surfaces, to map the wreck sites. The first wreck was found by accident (because the side-scan sonar never became operational) while testing a special, remotely operated underwater vehicle (TROV) with mounted cameras that produce 3-dimensional pictures of an object. The remainder of the 2-week expedition was spent investigating that site. While Navy divers were videotaping the first site, a second wreck was found. In all, four separate hull outlines may have been identified. Sites were mapped with GPS and were videotaped with the TROV and by divers (Bingham, 1998).

A follow-up marine archaeological expedition supported by the National Science Foundation and the Barrow Arctic Science Consortium took place in August 2005. Using specially designed compact sidescan sonar technology and an inflatable vessel, the small, shore-based team searched for the remains of the 1871 whaling wrecks. Historical research and Jeremy Project data dictated the location of the search area.

Nearly 250 side-scan anomalies were recorded in the 13 mi^2 (33.6 km^2) of sea bottom surveyed; of these hits, 71 were promising enough to warrant further investigation using a video camera. Unfortunately, weather conditions deteriorated and the field season expired before these anomalies could be explored or confirmed as potential wreck sites (Beebe and Jensen, 2006) Additional fieldwork is planned during 2015 to further evaluate these potential sites.

Any shipwrecks in the Leased 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 Leased Area (2007 FEIS, Vol. III, Map 7).

The geodatabase of Chukchi landforms that might be representative of archaeological sites to be updated provides information about features and anomalies of archaeological interest identified through seismic and geohazard surveys. These data are invaluable but are by no means complete. As an illustration, it may be helpful to consider the fact that the Chukchi Sea areas under consideration in this Second SEIS were once part 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 14,500 Before Present (B.P.) (Goebel and Buvit, 2011; Holmes, 2011; Potter, 2011). Previously, prehistoric archaeological resources were not expected in areas where water depths exceeded 60 m (197 ft), because these areas of the continental shelf would have become submerged by rising sea level prior to 13,000 years B.P. (USDOI, BOEMRE, 2011a).

Based on new data, humans would have occupied Beringia during the Pleistocene 25,000 B.P.-12,000 B.P. when it was emergent. This is 12,000 years earlier than previously thought. (Hoffecker, Elias, and O'Rourke (2014) pointed out that North America's indigenous people stayed in Beringia for almost 10,000 years before entering what is now North America. Multiple lines of evidence establish that people had migrated from northeast Asia to occupy Beringia about 25,000 years ago:

1. Pollen data and fossil insect remains from both sides of the Bering Strait indicate mild temperatures during the coldest phases of the Last Glacial Maximum of the Pleistocene (LGM). This may be attributable to the North Pacific circulation, which brought comparatively moist and warm air to southern Beringia during the LGM and may have ameliorated temperatures in northern Beringia, resulting in a shrub tundra refugium.
2. The analysis of DNA from human skeletal remains dating to 24,000 B.P. from southern Siberia appears to validate the pre-LGM divergence of Native Americans from their Asian Parent haplogroups. This individual had genetic similarities to both Europeans and indigenous Americans. Dubbed Ancient North Eurasians, this group is the recently revealed third population that contributed to the genetic complexity of modern Europeans, and occupied Europe prior to an invasion of agriculturalists 7,500 years ago. This group is something of a missing link, as they connect all modern Europeans and Native Americans (Lazaridis et al., 2014).

The multiple lines of evidence appear to confirm the assertion that ancestral Native Americans were isolated genetically from other populations for thousands of years before dispersal, probably in Beringia, as advanced in the Beringian standstill hypothesis (Tamm et al., 2014). As Hoffecker stated, "To confirm the hypothesis, archaeological sites of LGM age must be documented in Beringia…although most such sites presumably would be underwater" (Hoffecker, Elias, and O'Rourke, 2014).

Data suggest that early human populations lived isolated in Beringia for 10,000 years before the advent of the Holocene, before relocating in response to rising sea levels which occured at the advent of the Holocene. BOEM believes that the seabed of Beringia, regardless of depth, could have supported past human populations from 25,000 B.P. to 12,000 B.P. when the melting of the Pleistocene ice sheets and associated deterioration of Beringia resulted in abandonment of the now drowned land mass.

Onshore Archaeological Resources

Information for some of the approximately 312 known archaeological sites onshore in the Chukchi Sea coastal area is in the Alaska Heritage Resources Survey File (AHRS) (ADNR, 2006).

Historically, onshore archaeological resources near the Chukchi Sea coast receive less damage from the receding shoreline than do resources on the Beaufort Sea coast, which is subjected to more slumping because of water action and permafrost (Lewbel, 1984). The Chukchi Sea coast is eroding on an average of about 0.3 m (1 ft) per year (Harper, 1978). Although this erosion rate is considerably lower than that of the Beaufort Sea coast (1-2 m/yr or 3-6 ft/yr), it accounts for a coast on which new archaeological sites periodically appear because of erosion. Known onshore archaeological resources exist in great numbers and quality. Emerging communities, graves, whaling camps, and fishing/hunting camps have been found (Tornfelt, 1982).

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Chapter 4

Environmental Consequences

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CHAPTER 4. ENVIRONMENTAL CONSEQUENCES

This chapter presents an analysis of potential environmental, social, and economic impacts resulting from the oil and gas exploration, development, production, and decommissioning scenario developed for leases resulting from Chukchi Sea OCS Oil and Gas Lease Sale 193 (referred to hereafter as "the Scenario"). As a prelude to the environmental impacts analysis, the following subsections describe:

- The Scenario assumed for this analysis
- The oil and gas activities which comprise this Scenario
- Impact producing factors caused by those activities
- The structure of the ensuing environmental impacts analysis
- How overlapping activities will be addressed
- How impacts are addressed through time
- The levels of effect and significance thresholds used to measure impacts

4.1. Assumptions for Effects Assessment

BOEM created an exploration, development, production, and decommissioning scenario ("the Scenario") to provide a basis for the environmental effects analysis in this chapter. This Scenario represents the highest level of oil and gas activities that could reasonably result from Lease Sale 193. A summary of the Scenario, along with the assumptions and process used to create the Scenario, is provided in Section 2.3. A description of the methodology used to develop the Scenario along with a full schedule of activities is available in Appendix B.

The Scenario assumes that current lessees will explore their leases, successfully discover an anchor field as well as a satellite field, develop necessary infrastructure, and produce approximately 4.3 Bbbl of oil and 2.2 Tcf of natural gas from the leases issued from Lease Sale 193. The Scenario describes these activities as occurring over a period of 77 years (which includes decommissioning). Impacts from exploration, development, production, and decommissioning from potential future lease sales in the Chukchi Sea are considered.

The most likely result of Lease Sale 193 is the limited and unsuccessful exploration of leases, and nothing more. An "exploration-only" result is consistent with historical trends for the Chukchi Sea OCS as well as the majority of the economic simulations conducted by BOEM. The larger Scenario is, however, a possible outcome (assuming subsequent exploration plan and development and production plan approvals). The environmental impacts analyses provided in this chapter are predicated on the unlikely assumption that all of the oil and gas activities described in this Scenario will in fact occur.

4.1.1. Description of Oil and Gas Activities

The activities comprising the Scenario can be divided into three categories: exploration, development, and production/decommissioning. The activities associated with each phase are described below.

4.1.1.1. Exploration

Exploration includes those activities conducted to acquire information about the location, size, and characteristics of oil and gas prospects within the Leased Area. This includes activities conducted to acquire information about potential drilling locations, e.g. seafloor characteristics and/or drilling hazards. This also includes exploration and delineation well drilling. More specifically, these activities include:

- Marine seismic surveys (4-12 surveys over 25 years)

- Geohazard surveys (10-16 surveys over 28 years)
- Geotechnical Surveys (10-16 surveys over 28 years)
- Exploration and delineation well drilling (30-40 wells within a 20 year, discontinuous period)
- Construction of exploration base (1 base over 2 years)
- Associated vessel and aircraft traffic

Additional description of Exploration activities is provided in the following sections of the 2007 FEIS:

- IV.A.2.b(1). Marine Streamer Marine 3D and 2D Seismic Surveys
- IV.A.2.b(2). High-Resolution Site-Clearance Surveys
- IV.A.2.b(3). Drilling Operations
- IV.A.2.e. Transportation Activities
- IV.A.2.g. Estimates of Drilling Wastes and their Disposal

4.1.1.2. Development

Development includes those activities conducted to create the infrastructure necessary for production. More specifically, these activities include:

- Installation of offshore platforms (8 over 26 years)
- Production well drilling (400-457 wells over 25 years)
- Service well drilling (80-92 wells over 25 years)
- Installation of offshore oil pipelines (190-210 miles over 25 years)
- Installation of an onshore oil pipeline (300-320 miles over 4 years)
- Installation of offshore gas pipelines (190-210 miles over 25 years)
- Installation of onshore gas pipeline (300-320 miles over 4 years)
- Construction of a shorebase (1)
- Construction of a processing facility (1)
- Construction of a waste facility (1)
- Associated vessel and aircraft traffic

Additional description of Development activities is provided in the following sections of the 2007 FEIS:

- IV.A.2.c. Development Activities
- IV.A.2.b(3). Drilling Operations
- IV.A.2.e. Transportation Activities
- IV.A.2.g. Estimates of Drilling Wastes and their Disposal

4.1.1.3. Production

Production includes those activities conducted to extract oil and gas resources from the ground and transport them to market. Also included in Production are decommissioning activities. More specifically, these activities include:

- Oil production (4.3 Bbbl over 44 years)
- Gas production (2.2 Tcf over 44 years)
- Vessel traffic (8-16 trips per week - shorebase to platform and back)

- Aircraft traffic (56-168 flights per week - Barrow/Wainwright to platform and back)
- Decommissioning (platforms/pipelines over 24 years)
- Additional description of Production activities is provided in the following sections of the 2007 FEIS:
- IV.A.2.d. Production Activities
- IV.A.2.b(3). Drilling Operations
- IV.A.2.e. Transportation Activities
- IV.A.2.g. Estimates of Drilling Wastes and their Disposal
- IV.A.2.f. Abandonment Activities

4.1.2. Impact Producing Factors

The oil and gas activities listed above have the potential to affect resources in various ways. This subsection identifies the Impact Producing Factors, or IPFs, caused by these activities. These IPFs will be referenced in the resource-specific analyses of this chapter to the extent they are relevant in understanding impacts to a given resource. Each resource-specific subsection of Chapter 4 begins by identifying the IPFs relevant to the resource at hand and describes the types of impacts which may occur to that resource. The IPFs associated with this Scenario include:

4.1.2.1. Noise

Noise, whether carried through the air, ice, or under water, may cause some species to alter their behavior, including changing feeding routines, movement, and reproductive cycles. Concerns about noise have been raised because of the potential effects on animals, particularly marine mammals and fish, as well as effects on Alaska Native subsistence activities. These concerns apply to both underwater and atmospheric noise. Sources of noise associated with the oil and gas activities encompassed by this Scenario include vessels, seismic surveys, aircraft, facility construction, drilling, production and maintenance, decommissioning, and spill response and cleanup. Additional description of how noise may impact environmental resources is provided in the 2007 FEIS (Section IV.A.3.b).

4.1.2.2. Physical Presence

The physical presence of vessel and platforms can affect environmental resources in the vicinity of operations. There is also potential that environmental resources may collide with vessels or their propellers, or become entangled in oil and gas-related equipment. Additional description of how the presence of vessels and platforms may impact environmental resources is provided in the 2007 FEIS (Section I.ES.4).

4.1.2.3. Discharges

Several forms of routine permitted discharges from oil and gas activities can affect environmental resources. Muds and cuttings are discharged from the drilling of wells. Graywater is discharged from vessels, platforms, and onshore facilities. Ballast water is discharged from vessels. Facilities can also introduce heat into the environment, i.e. thermal discharges. Finally, many types of equipment associated with oil and gas activities discharge emissions into the air. Additional description of how discharges may affect the marine environment is provided in the 2007 FEIS (Section IV.A.3.d). Additional description of impacts from emission to air is provided in the 2007 FEIS (Section IV.C.1.b).

4.1.2.4. Habitat Alteration

Oil and gas related activities can destroy, disturb, alter, or convert habitats used by various biological resources for critical life functions. Additional description of how habitat alteration may impact environmental resources is provided in the 2007 FEIS (Section IV.A.3.c, page. IV-16).

4.1.2.5. Accidental Oil Spills and Gas Releases

Stakeholders have expressed concern about the potential for oil and gas exploration, development, or production activities to release or spill hydrocarbons into the environment. Gas releases and oil spills are illegal, unplanned, accidental events. With the exception of rare events, like the Deepwater Horizon, the number of spills and the volume of oil entering the environment from accidental spills have been decreasing in recent decades, even as petroleum consumption has risen (USCG, 2012; USEIA, 2014).

This section summarizes technical information from Appendix A to create a set of assumptions for purposes of environmental effects analysis. The background information from which these assumptions are derived is provided in Appendix A.

This Second SEIS analyzes the effects of reasonably forseeable oil spills from a Scenario entailing 4.3 Bbbl of oil production. The assumptions were developed using technical information and historic data (detailed in Appendices A and B), as well as project-specific information, modeling results, statistical analysis, and professional judgment. The analyses are based on a set of assumptions about the number, volume, and types of spills estimated to occur during the different phases. As shown in Figure 4-1, the oil-spill analyses consider the potential for small, large, and very large spills to occur during two general activity phases: (1) exploration and (2) development and production. The assumptions are discussed in the sections that follow. These assumptions apply to Alternatives I, III, and IV of this Second SEIS.

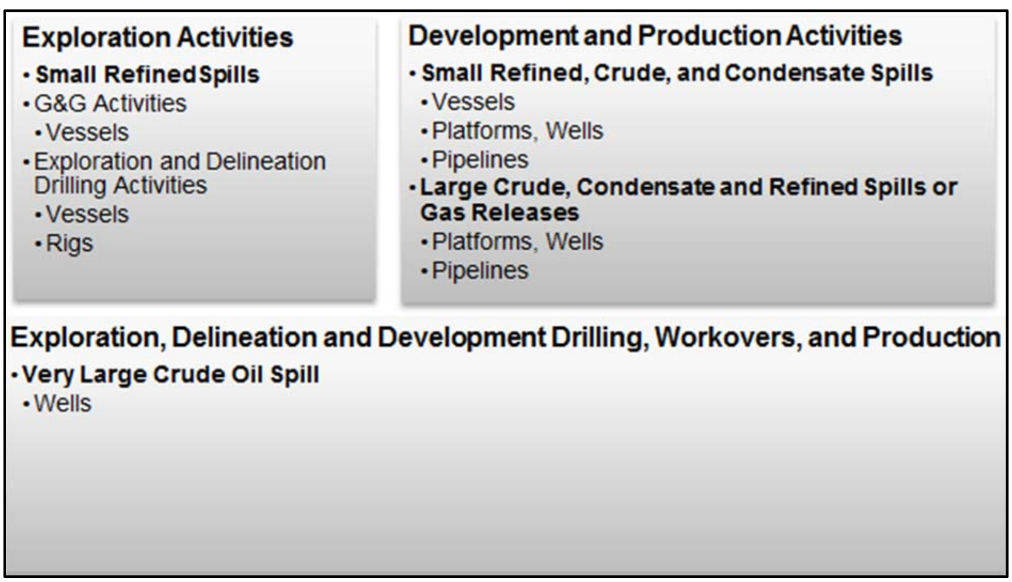


Figure 4-1. Type and Sizes of Oil and Gas Spills by Phase and Source. *The Figure identifies the types and sizes of spills and their associated sources for each phase of oil and gas activity analyzed in Sections 4.3 or 4.4.*

Small Oil Spills: <1,000 bbl

Small spills, although accidental, have occurred with generally routine frequency and are considered reasonably foreseeable to occur from both Exploration and Development and Production activities. The majority of small spills would be contained on a vessel or platform, and refined fuel spills that reach the water would evaporate and disperse within hours to a few days. Further, those spills reaching the water may be contained by booms or absorbent pads. The subsections below estimate the number and size of small spills that could occur during various phases of the Scenario.

Summary of Assumptions about Small Spills

BOEM bases the analysis of effects from small oil spills for Alternatives I, III, and IV on the assumptions in Table 4-1. BOEM estimates about 800 small spills would occur over the course of the 77-year Scenario. These estimated small spills are totaled and rounded to the nearest hundred. Details are further discussed below.

Table 4-1. Small Spill Assumptions.

Variable	Assumption for Purposes of Analysis
Number	800 total – Rounded to nearest hundred
Activities	Small refined oil spills occur during geological and geophysical activities, exploration and delineation drilling activities, and development and production activities. Small crude and condensate oil spills occur during development and production activities.
Timing	Small refined oil spills during geological and geophysical or exploration and delineation activities would occur during the open-water season (July- early November). Small refined and crude oil spills during development and production could occur any time of the year.
Size	Geological and geophysical activities: most would be <1 bbl, one would be up to13 bbl Exploration and Delineation Drilling: most would be 0 up to 5 bbl, some would be up to 50 bbl. Development and Production: most would be 3 bbl; two would be 700 bbl. One of the 700 bbl spills is assumed to occur from the onshore pipeline.
Medium Affected	• production facility and then the water or ice • open water • broken ice • on top of or under solid ice • shoreline • tundra or snow
Weathering	50 bbl evaporates and disperses within 3 days. Spills of <1 bbl evaporate and disperse within 10 hours.

Exploration

Small refined oil spills may occur during Exploration. The estimated total and annual number and volume of small refined oil spills during Exploration activities is displayed in Table 4-2. BOEM estimates about 35 spills occur during exploration ranging in size from <1 bbl up to 50 bbl per spill. Exploration is divided into Geological and Geophysical activities (marine, geohazard, and geotechnical surveys) and exploration and delineation drilling activities. Spills during Exploration are expected to be small and consist of refined oils because crude and condensate oils would not be produced during exploration. Refined oil is used in the drilling activity for the equipment and refueling.

Table 4-2. Annual and Total Potential Small Spills for Identified Oil and Gas Activities.

Activity Phase	Estimated Total Number of Small Spills	Estimated Total Volume of Small Spills (bbl)	Estimated Annual Number of Small Spills	Estimated Annual Volume of Small Spills (bbl)
	Small Refined Oil Spills			
Exploration Geological and Geophysical Activities	0 – 15	0 - < 27	0 – 3	0 - < 3 or <13
Exploration and Delineation Drilling	0 – 20	0 - < 145	0 - 2	0 - < 55
Development and Production	0 - 520	0 -1,600	0 - 12	0 - 36
	Small Crude or Liquid Natural Gas Condensate Oil Spills			
Development and Production	0- 222	0- 2,000	0 - 5	0 - 680

Note: Table represents the number and volume of small spills estimated to occur annually and in total for the identified oil and gas activities.

Development and Production

Crude, condensate, or refined small oil spills may occur during Development and Production. About 750 small crude and refined spills could occur during Development and Production. Of those, about

220 are small crude or condensate oil spills ranging from >1 bbl up to 50 bbl which could occur during the 44-year crude or condensate oil-production period, which is an average of about 5 spills per year. In addition to the 220 small crude or condensate spills just discussed, an estimated two small crude or condensate oil spills ≥500 bbl and <1,000 bbl could occur during the 44-year oil-production period. Of those two small crude oil spills ≥500 bbl and <1,000 bbl, one is assumed to occur offshore (from platforms or pipeline), and one is assumed to occur onshore (from the 300 mi onshore pipeline).

An estimated 260 refined-oil spills >1 bbl could occur during the 44-year oil-production period for Alternatives I, III, and IV, an average of about 6 spills per year. Likewise, BOEM estimates 260 refined spills could occur over the 44-year gas-sales production period.

Overall, estimates of crude, condensate and refined oil spills >1 and <1,000 bbl assumed to occur during each year of Development and Production are 11 for Years 10-30, 17 for Years 31-53 and 6 for Years 54 to 77.

Large Oil Spills: ≥1,000 bbl

Large spills, although accidental, are estimated to occur from Development and Production activities and therefore are reasonably foreseeable. Two large spills of crude, condensate, or refined oil are assumed to occur during the Development and Production phases. This assumption is based on considerable historical data that indicates large OCS spills ≥1,000 bbl may occur during this phase (Anderson, Mayes, and Labelle, 2012). This assumption is also based on statistical estimates of the mean number of large spills from platforms, wells, and pipelines, the number and size of large spills on the OCS, and project-specific information in the Scenario. The mean number of large spills is calculated by multiplying the spill rate from the Fault Tree model by the estimated resources produced (4.3 Bbbl). By adding the mean number of large spills from platforms and wells (0.5) and from pipelines (0.9), a mean total of 1.4 large spills was calculated for the Scenario. Based on the mean spill number, a Poisson distribution indicates there is a 75% chance of one or more large spills occurring over the 77 years of the Scenario, and a 25% chance of no spills occurring.

Table 4-3. Large Spill Assumptions.

Variable	Assumption for Purposes of Analysis
Number	2 large spills occurring during the 64 years of oil and gas development and production
Percent chance of one or more occurring	75% Chance of One or More Large Spills Occurring
Activities	Large spills occur during development or production. No large spill occurs during geological and geophysical activities or exploration and delineation drilling activities.
Timing	Large spills occur any time of the year Large spills do not occur in the same time and space; but at punctuated intervals throughout 64 years. Large crude, condensate, or diesel spills could occur during the 44 years of crude oil or natural gas liquid condensate production. Large diesel spills could occur during sales gas production.
Size and Oil Type	Pipeline 1,700 bbl crude or condensate oil Platform 5,100 bbl crude, diesel or condensate oil
Medium Affected	• production facility and then open water or ice • open water • broken ice • on top of or under solid ice • shoreline • tundra or snow
Weathering After 30 days	Condensate and diesel oil will evaporate and disperse much more rapidly than crude oil, generally within 1-13 days. After 30 days in open water or broken ice, BOEM assumes the following weathering for crude oil: • 28-40% evaporates, • 3-16% disperses, and • 44-62% remains.

Variable	Assumption for Purposes of Analysis
Chance of Large Spill Contacting and Timing	The time to contact and chance of contact from a large oil spill are estimated from an oil-spill-trajectory model (Appendix A, Tables A.2-1 through A.2-72). Assuming a large spill occurs, the chance of contact is analyzed from the location where it is highest when determining impacts.
Chance of One or More Spills Occurring and Contacting	The overall chance of one or more large oil spills occurring and contacting is calculated from an Oil-Spill-Risk Analysis (OSRA) model (Appendix A, Tables A.2-73 through A.2-75).
Spill Response	The OSRA does not account for response, cleanup, or containment and therefore may overestimate the chance of a large spill contacting environmental resource areas (ERAs), land segments (LS) or grouped land segments (GLS). Cleanup is analyzed separately as mitigation or disturbance.

For the purpose of the analysis, BOEM assumes that two large spills would occur during the Scenario. Assuming a number of spills that is higher than the most likely number of spills helps to ensure that this Second SEIS does not underestimate potential environmental effects.

The assumptions BOEM uses to analyze the potential effects of large crude, condensate, or refined oil spills that could occur from development and production, are set forth in Table 4-3. The analysis of the potential effects from large spills is contained in Sections 4.1.3 through 4.1.4.

Based on OCS historical data, no large spills are assumed to occur during the exploration phase of oil and gas activities. This assumption is based on a robust set of historical data about oil spills. Of over 15,000 exploration wells drilled on the OCS from 1971-2010, no crude oil spills ≥1,000 bbl have occurred, other than the Deepwater Horizon (DWH) incident. The DWH falls within a subset of large spills referred to as "very large oil spills" (VLOS), which is defined as spills greater than 150,000 bbl, and is considered a low-probability, high-impact event. In other words, a spill of this volume is highly unlikely to occur during any activity phase, but if one did occur (as the DWH), the impacts would be substantial. In Section 4.4, BOEM addresses the possibility of a VLOS occurring, uses historic data to assess the likelihood of a VLOS occurring, and analyzes the potential environmental effects of such an event.

Gas Releases

The Scenario estimates 2.2 Tcf of dry gas will be produced over 44 years, and up to 3 potential gas releases ranging from 10-20 million cubic feet each and explosion hazards in confined spaces could occur. This analysis estimates one 10 million cubic foot release occurs offshore from the facility and two 20 million cubic feet releases occur onshore from the 300 mi gas pipeline.

The Scenario through Time: Oil Spills

The Scenario through time includes overlapping activity phases; Table 4-4 shows the size, type and timing of oil and gas spills estimated to occur throughout the life of the Scenario as described in the next section, 4.1.3. In BOEM's analyses, the potential effects of oil spills and gas releases are analyzed for the activity phases in which they are estimated to occur.

Table 4-4. Generalized Size, Type, and Timing of Spill.

Spill Size	Spill Type	Assumed Potential to Occur in Activity Phase
Small	Refined	Geological and Geophysical Surveys and Exploration Drilling; Exploration Ends: Year 28
Small	Refined	Development, Production and Decommissioning
Small	Crude or Condensate	Oil Development and Production; Oil Production Ends: Year 53
Large	Crude or Condensate	Oil Development and Production; Oil Production Ends Year 53
Large	Diesel	Oil and Gas Development and Production; Gas Production Ends: Year 74
	Gas Release	Gas Production Starts Year 31; Gas Production; Gas Production Ends: Year 74

Activity Phase Through Time					
	Exploration (Years 1-5)	*Exploration and Development (Years 6-9)*	*Exploration, Development and Production (Years 10-25)*	*Development and Production (Years 26-50)*	*Production and Decommissioning (Years 51-77)*

4.1.3. Analysis and Summary of Effects

After relevant IPFs are identified and their potential effects are described, each resource-specific subsection within Chapter 4 will then track the progression of the Scenario through time. This discussion organizes the 77-year Scenario into five distinct periods. The twin goals of this discussion are to:

1. Chronologically discuss the oil and gas exploration, development, production, and decommissioning activities which comprise the Scenario
2. Identify the types and assess the levels of environmental impacts that may occur along the way

The reader will note that as the Scenario progresses, one, two or even all three different phases of activities – i.e. Exploration, Development, and Production – will proceed concurrently within these five periods. This overlap is illustrated in Table 4-4. The environmental impacts analyses provided in each resource-specific subsection of Chapter 4 will address all of the overlapping activities that occur within each of the five time periods. A summary of potential impacts from relevant oil and gas activities is provided for each period for each resource. A final conclusion – i.e. a determination of the scale of the impacts– is then provided for the resource as a whole.

Again, about 800 small oil spills and 1-2 large oil spills referenced above and assumed for this analysis may occur at any time from commencement of exploration drilling to end of production.

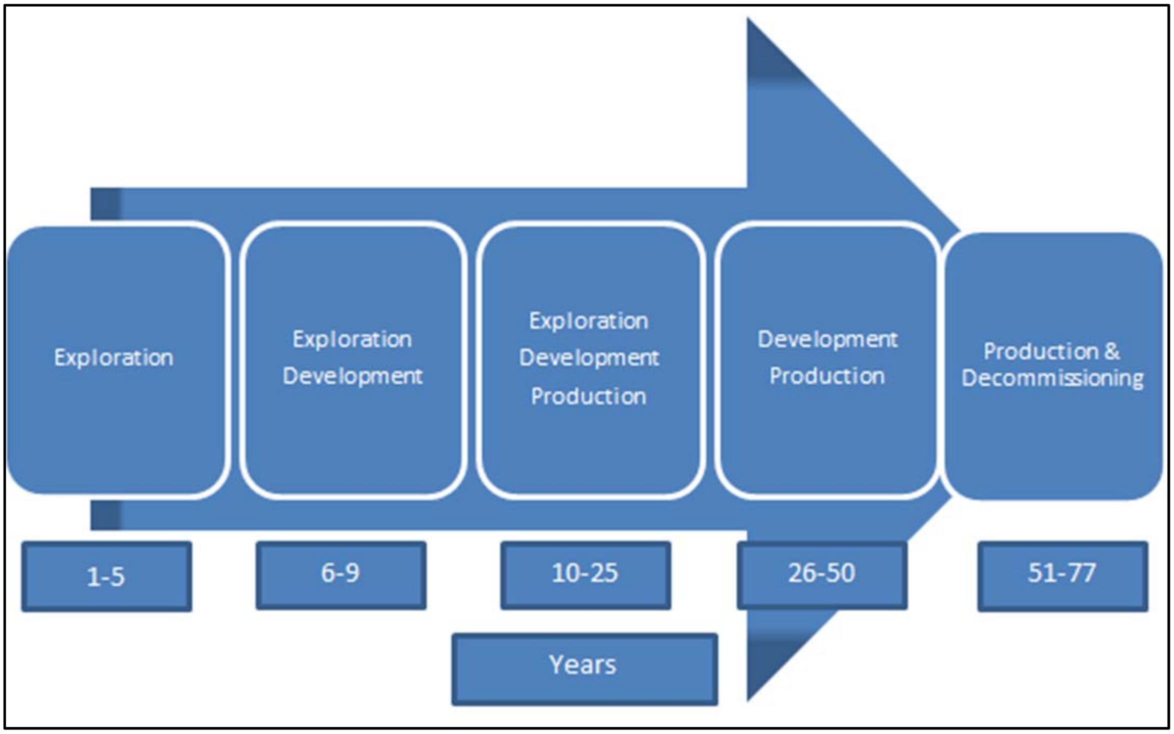


Figure 4-2. Oil and Gas Activities through Time. *Figure illustrates the flow of types of oil and gas activities that would occur through time as the Scenario unfolds.*

Phase #1: Exploration (Years 1-5)

The Scenario commences with exploration of blocks leased as a result of Lease Sale 193 (referred to hereafter as the Leased Area). Lessees will seek to further their understanding of the geology of their leased areas by conducting a marine seismic survey. Once viable prospects are identified, lessees will conduct geohazard surveys and geotechnical surveys to identify more specifically proposed exploration drilling sites, and to identify hazards associated with these locations. Once BOEM approves exploration plans and BSEE issues drilling permits, lessees will drill exploration and delineation wells to determine the presence and quantity of hydrocarbons within targeted reservoirs. The Scenario contemplates two mobile offshore drilling units (MODUs) drilling two wells each per year over Years 3-5.

There are no OCS oil or gas development or production activities overlapping with this phase. In fact, if initial exploration activities prove unsuccessful, then no oil or gas development or production would occur as a result of Lease Sale 193.

This Scenario assumes, however, that successful exploration drilling of a large prospect leading to the establishment an anchor field occurs during this phase. The drilling of exploration and delineation wells will further establish the extent of the reservoir and help determine the placement of platforms and production wells.

Phase #2 Exploration and Development (Years 6-9)

The discovery of an anchor field precipitates the development of infrastructure necessary to produce oil. A shorebase and a supply marine vessel terminal are constructed in Years 5 and 6. Installation of 300 miles of onshore oil pipeline and 160 miles of offshore oil pipeline occurs during Years 6-9 in preparation for production from the first platform, which is installed in Year 10 (Period 3, below).

Exploration activities (to include marine seismic surveys, geohazard surveys, geotechnical surveys, and exploration drilling) continue throughout this phase, as lessees will search for additional fields now considered economic in light of the successful development of the anchor field. The Scenario contemplates two exploration MODUs drilling two wells each per year during this phase.

Phase #3: Exploration, Development, and Production (Years 10-25)

Exploration activities and development of the anchor field continue during this period. Production of oil commences, meaning all three categories of oil and gas activities – exploration, development, and production activities – occur during this phase.

A satellite field is developed during the latter years of this phase. The continuation of exploration activities results in the discovery, and delineation of another economic field. The ensuing development, though relatively smaller in scale, follows a similar pattern to development of the anchor field. For the anchor field, additional offshore production platforms are constructed, on-platform production and service wells, as well as subsea wells, are drilled (with up to four drilling units operating at one time), and offshore pipelines are installed. These activities utilize the existing production base, supply boat terminal and onshore pipeline.

Overall, exploration activities during this phase consist of five marine seismic surveys (Years 11, 15, 19, 21 and 25), one geohazard survey (Year 20), one geotechnical survey (Year 20) and 12 exploration or delineation wells (4 units drilling 4 wells per year from Years 20-22).

Development activities during this phase entail installation of six offshore production platforms (Years 10, 13, 16, 19, 22 and 24). On-platform production and service wells (between 3 and 32 per year from Years 10-25) are also drilled, as are subsea wells (between 6 and 9 per year from Years 12-23). Pipelines are installed between the anchor fields and the satellite field (Years 13-23).

The production of oil and natural gas liquid condensate which commenced in Year 10 gradually ramps up until it peaks in Year 23, at which point it begins a slow decline.

Phase #4 Development and Production (Years 26-50)

The fourth phase features additional development of the satellite field and the continuation of oil production from both the anchor field and satellite field. Development activities during this phase entail installation of two offshore production platforms (Years 27 and 30). On-platform production and service wells (between 2 and 21 per year from Years 26-34) are also drilled. Pipelines are installed between the satellite field platforms (Years 27 and 30). As oil production from wells on the anchor field declines, existing oil and natural gas liquid condensate production platforms and wells are converted to natural gas production. This transition is gradual, as oil production continues during this entire phase. More and more oil production platforms and wells are incrementally converted to gas production platforms and wells as the years go by. Installation of the onshore gas pipeline occurs from Years 27-29. Installation of offshore gas pipelines also commences in Year 27 and continues sporadically over the ensuing 23 years.

Phase #5 Production and Decommissioning (Years 51-77)

The fifth and final phase is characterized by the end of oil production, declining gas production, and decommissioning of infrastructure associated with each. As wells reach the end of their economic lives, they are taken offline and plugged with cement. Platforms will be removed and pipelines will be decommissioned. Production ends in Year 74; decommissioning is completed in Year 77.

4.1.4. Analyzing Impacts at the Lease Sale Stage

This analysis occurs at the lease sale stage, which is the second stage of BOEM's four-stage process under OCSLA. Although a lease holder may conduct ancillary activities on lease, the purchase of a lease entails no right to proceed with full exploration, development, or production; the lessee must submit plans and receive all requisite approvals before proceeding with these activities.

Prior to any exploration drilling (third stage), a lessee must submit an Exploration Plan (EP) and receive approval by BOEM, which conducts a detailed and site-specific NEPA analysis of each plan. At the fourth stage, an approved Development and Production Plan (DPP) is required before a lessee may commence developing infrastructure necessary to produce oil and gas (fourth stage). BOEM conducts another detailed, site-specific NEPA review on each proposed DPP. Only if a proposed EP or DPP meets the substantive standards established in BOEM regulations at 30 CFR §550.202 may BOEM approve the plan. BOEM will also require a lessee to implement any mitigation measures deemed necessary by its plan- and site-specific reviews. In addition, a lessee must submit an application to permit to drill (APD) for any well and receive approval from BSEE; BSEE ensures that lessees meet the regulations at 30 CFR 250 and 30 CFR 254.

BOEM's NEPA analyses through its four-stage OCSLA process (Five-Year Program, Lease Sale, Exploration, Development, and Production) are as specific and quantitative as the circumstances allow. However, it must be recognized that accurate projection and description of impacts becomes increasingly difficult as one proceeds further into the future. These challenges are particularly relevant here, given the 77-year time horizon of the Scenario. The analysis of potential impacts occurring later in time, and at later stages of the OCSLA process, may necessarily become more conceptual and qualitative.

4.1.4.1. Area of Effects

The area of effects depends on factors that differ across resources, such as the location and mobility of the resource, the nature and timing of the impacts, and aspects of the affected environment. For example, some resources are stationary (e.g., vegetation or a community), while others are mobile (e.g., whales). As a result, the area of effects is specific to each resource. In this Second SEIS, the appropriate area of effects for each resource is reflected in the resource-specific analyses within this chapter.

4.2. Impacts Scale

The analyses in this chapter apply a scale to categorize the potential impacts to specific resources and evaluate the significance of those impacts. The scale takes into account the context and intensity of the impact based on four parameters: detectability, duration (i.e., short-term or long-lasting), spatial extent (i.e., localized or widespread), and magnitude (i.e., less than severe or severe, where the term "severe" refers to impacts with a clear, long lasting change in the resource's function in the ecosystem or cultural context).

Analysts used the best available information and their professional judgment to determine where a particular effect falls in the continuum on a relative scale from "negligible" to "major." Impacts that fall in the category of "major" were considered to be significant under NEPA. For biological resources, impacts were determined based on changes on the stock or population, rather than the individual level.

The impacts scale applied in this Second SEIS is as follows:

- **Negligible:** Little or no impact
- **Minor:** Impacts are short-term and/or localized, and less than severe
- **Moderate:** Impacts are long lasting and widespread, and less than severe
- **Major:** Impacts are severe

In applying this scale and the terms that describe impact categories (levels of effect), analysts took into consideration the unique attributes and context of the resource being evaluated. For example, for impacts to biological resources, attributes such as the distribution, life history, and susceptibility of individuals and populations to impacts were considered, among other factors. For impacts to subsistence activities, factors considered include the fundamental importance of these activities to cultural, individual and community health, and well-being. Based on these unique characteristics, impacts to subsistence activities are considered long-lasting and severe, and thus, major and significant, if they would disrupt subsistence activities, make subsistence resources unavailable or undesirable for use, or only available in greatly reduced numbers for a substantial portion of a subsistence season for any community.

In developing this impacts scale, BOEM considered the approaches used by other Federal agencies in their NEPA analyses of other proposed Federal actions, including other actions in the Arctic. Examples include the approaches set forth in the Final Programmatic EIS for the Atlantic OCS Proposed Geological and Geophysical Activities (USDOI, BOEM, 2014b); National Petroleum Reserve in Alaska (NPR-A) Final Integrated Activity Plan/EIS (USDOI, BLM, 2012); Alaska Stand Alone Gas Pipeline EIS (USACE, 2012b); and the Point Thomson EIS (USACE, 2012a).

4.3. Effects of Oil and Gas Exploration, Development, and Production

As explained in Section 2.1.1, the Proposed Action is to affirm Lease Sale 193, which would result in 460 current leases in the Chukchi Sea Program Area (see Figure 1-2). No new leases will be issued pursuant to this lease sale. This makes Alternative I (Proposed Action) and Alternative IV (Corridor II Deferral) effectively the same for the purpose of analysis; both Alternatives would address the potential effects of activities related to the 460 current leases. If Alternative III (Corridor I Deferral) were selected, the five leases within the Corridor I Deferral would be vacated. In the analyses below, BOEM analyzes Alternatives I and IV together as one, and provide separate analyses for Alternative II (No Action) and Alternative III (Corridor I Deferral).

4.3.1. Water Quality

4.3.1.1. Alternatives I and IV

Impact Producing Factors

This section identifies the IPFs associated with oil and gas exploration, development, and production phases that would affect water quality. It discusses the manner in which each identified IPF can affect water quality. IPFs are organized by phase of oil and gas activity (i.e, exploration, development, production, and decommissioning). IPFs which occur during multiple phases are addressed in the phase in which they first appear. Accidental spills, though not considered a routine oil and gas activity, have the potential to occur during each phase of oil and gas operations. The types of impacts of small and large oil spills and gas releases are analyzed in the phase in which they first have the potential to occur. The impacts of oil spills or gas releases are then analyzed under “Impacts of the Scenario through Time” within this section.

The 2007 FEIS and 2011 SEIS contain background information about the IPFs on water resources; this information is discussed briefly below. Additional background information is contained in the following EPA documents:

- Biological Evaluation In Support of the Chukchi Sea Oil and Gas Exploration (National Pollutant Discharge Elimination System) NPDES General Permit (EPA, 2012a)
- Ocean Discharge Criteria for Oil and Gas Exploration Facilities on the Outer Continental Shelf in the Chukchi Sea, Alaska, NPDES Permit No.: AKG-28-8100 (EPA, 2012b)
- Chukchi Sea Environmental Monitoring Program Requirements Summary (EPA, 2012c)
- Results from Chukchi Sea Permit Dilution Modeling Scenarios (EPA, 2012d)

- NPDES General Permit for Oil and Gas Exploration Facilities on the Outer Continental Shelf in the Chukchi Sea, Alaska (EPA, 2012e)
- Vessel General Permit (VGP) for Discharges Incidental to the Normal Operation of Vessels Authorization to Discharge under the National Pollutant Discharge Elimination System (EPA, 2013a)

Exploration

Exploration activities would affect various water resource environments (marine, estuarine, freshwater) and at different depths. Activities in the exploration phase that would affect water resources are presented in Table 4-5.

Table 4-5. Exploration Activity Types and Water Resource Environments Affected.

Type of Exploration Activity that Would Affect Water Resources	Environment and Depth[1] Affected - Exploration			
	Marine: Surface Water, Ice	Marine: Midwater Column	Marine:Bottom-water or Seafloor Sediments	Estuarine or Freshwater-all depths
Excavation sediments (well cellar cuttings)			x	
Drill cuttings (from exploration well)			x	
Cuttings with adhered drilling fluids		x	x	
Water-based drilling fluids		x	x	
Excess cement discharge	x	x	x	
Blow-out preventer fluid	x			
Sanitary waste discharge	x	x		
Domestic waste discharge	x	x		
Cooling water discharge	x	x		
Desalination brine water discharge	x	x		
Ballast water discharge	x	x		
Bilge water (treated onboard) discharge	x	x		
Deck drainage (separated onboard)	x			
Setting and driving support legs (jack-up rig)			x	
Setting seafloor supports (jack-up rig)			x	
Seafloor core sampling sediments			x	
Seawater Withdrawals	x	x		
Accidental refined oil spills < 1,000 barrels	x			x

[1]Notes: Surface Water and Sea Ice (surface to ~10 m depth (33 ft)
Midwater (~10 m to ~ 3 m (33-9.8 ft) above seafloor)
Bottomwater (up to ~3 m (9.8 ft) above seafloor)
Seafloor Sediments (to 1 m (3.2 ft) below seafloor)

Discharges

Drilling Muds and Cuttings; Wastewater. There are several types of discharges that can occur during exploration, as well as the other phases of oil and gas operations. Discharges from exploration operations in Federal waters of the Chukchi Sea are permitted under a NPDES General Permit that is issued by EPA and have a term of five years (please note that the State of Alaska has been delegated authority for these discharges in State waters out to three miles). Discharges under a General Permit for exploration typically include sanitary waste, domestic waste, drilling fluids, drilling cuttings, and deck drainage. Detailed information on the various types and properties of discharges from routine oil and gas activities is contained in the 2007 FEIS (Section IV.C.1.a(4)).

The current NPDES General Permit for exploration discharges in the Chukchi Sea is the 2012-2017 NPDES General Permit for Oil and Gas Exploration Facilities on the Outer Continental Shelf in the Chukchi Sea (AK 28-8100) (EPA, 2012e). The terms of this permit are indicative of the expected terms of future General Permits. The types of discharges in the current 2012-2017 General Permit are presented in Table 4-6.

Table 4-6. Discharges Permitted for Chukchi Sea Exploration Facilities 2012-2017.

Types of Discharge Permitted in the Current NPDES General Permit	Depth of wastewater discharge into the Offshore Marine Environment[1]
Water-Based Drilling Fluids and Drill Cuttings	Surfacewater, Midwater
Deck drainage	Surfacewater
Sanitary wastes	Surfacewater, Midwater
Domestic wastes	Surfacewater, Midwater
Desalination unit wastes	Surfacewater
Blowout preventer fluid	Bottomwater, Seafloor sediments
Boiler blowdown	Surfacewater (commonly, directly to surface)
Fire control system test water	Surfacewater (commonly, directly to surface)
Non-contact Cooling Water	Surfacewater (commonly, directly to surface)
Uncontaminated ballast water	Surfacewater
Bilge water	Surfacewater
Excess cement slurry	Bottomwater, Seafloor sediments
Muds, Cuttings, Cement at the Seafloor	Bottomwater, Seafloor sediments

Note: Types of Discharges Permitted for Exploration Facilities in the Chukchi Sea 2012-2017.

[1]Surface Water and Sea Ice (surface to ~10 m (33 ft) depth); Midwater (~10 m to ~ 3 m (33-9.8 ft) above seafloor); Bottomwater (up to ~3 m (9.8 ft) above seafloor); Seafloor Sediments (to 1 m (3.2 ft) below seafloor)

Source: General Permit for exploration facilities in the Chukchi Sea, 2012-2017 (EPA, 2012b).

During exploration, drill cuttings, water-based drilling fluids, and excavation sediment would be discharged into the water and on the seafloor. Exploration drilling discharge estimates and well cellar excavation volumes are presented in Table 4-7.

Table 4-7 Discharge Volumes to Water and Seafloor in Construction of Exploration Wells.

Type of Discharge	Estimated Exploration Well Discharge Volume		
	1 Well (ft^3)	4 Wells in One Year (ft^3)	40 Wells over Scenario (ft^3)
Cuttings only – drilling and mudline cellar construction over 38 days/well	22,554 ft^3	90,216 ft^3	902,160 ft^3
Drilling fluids and cuttings over 38 days/well	41,245 ft^3	164,980 ft^3	1,649,800 ft^3
Total for time period	63,799 ft^3	255,196 ft^3	2,551,960 ft^3

Note: Volume of Drill Cuttings, Drilling Fluids and Well Cellar Sediment Discharged into Water and on Seafloor for Construction of Exploration Wells.

Estimates of discharges are based on the Notice of Intent for exploration drilling in the Chukchi Sea submitted by a lessee to EPA, 2010; an exploration well is based on operating 38 days/well.

1 bbl = 0.159 m^3 = 35 ft^3

As a result of the physical and chemical heterogeneity of typical drill cuttings and drilling fluids, the mixture would undergo fractionation (separate into various components) as it is discharged to the ocean. The larger particles, which represent about 90% of the mass of drilling mud solids, would settle rapidly out of solution, whereas the remaining 10% of the mass of the mud solids consists of fine grained particles that would drift with prevailing currents away from the drilling site (Neff, 2005; Neff et al., 2010). The fine-grained particles would disperse into the water column and settle slowly over a large area of the seafloor. Models, lab-scale simulations, and field studies suggest that discharged drilling muds and cuttings would be rapidly diluted to very low concentrations, and that suspended particulate matter concentrations would drop below effluent limitation guidelines within several meters of the discharge (Neff, 2005; Netto, Fonseca, and Gallucci, 2010). In well-mixed waters, particles discharged to the ocean from drilling activities are typically diluted by 100-fold within 10 m (33 ft) of the discharge and by 1,000-fold after a transport time of about 10 minutes at a distance of about 100 m (328 ft) from the platform (Neff, 2005). Material discharged during drilling and construction activities would be similar in composition to naturally-occurring seafloor sediments, and its contribution to turbidity from waves and currents would be about the same as the sediments existing at the seafloor surface before drilling activities (USDOI, BOEM, 2012). Experiments have shown the composition of deposited materials have an effect on recolonization of benthic communities, with natural sediments from disturbance of the benthic surface having less adverse effect on the recolonization rate than drilling muds, and water based drilling muds having less effect than synthetic muds (Trannum et al., 2011).

The discharge of drill cuttings and drilling muds associated with exploration and development, drilling activity, and drilling of service wells during production, would create increased turbidity and increased concentrations of total suspended solids in the water column. Drill cuttings and water-based drilling fluids are comprised of a slurry of particles with a wide range of grain sizes and densities, and various fluid additives may be water soluble, colloidal, or particulate in nature (Neff, 2005). Drill cuttings are particles of sediment and rock extracted from the bore hole as the drill bit penetrates the earth. Water-based drilling fluids consist of water mixed with a weighting agent (usually barium sulfate, $BaSO4$) and various additives to modify the properties of the mud (Neff, 2005, Neff et al., 2010). In the immediate vicinity of exploratory drilling and anchor handling activities, turbidity may locally exceed the 7,500 ppm threshold. Particles that are temporarily suspended in the water column near construction sites of platforms and during drilling activities probably would exceed thresholds set by the EPA (EPA, 2012b). Turbidity above ambient levels caused by increases in suspended particles in the water column would affect water quality in the Proposed Action area. Turbidity levels are generally expected to remain considerably below 7,500 ppm suspended solids (NRC, 1983). In the immediate vicinity of exploratory drilling and anchor handling activities, turbidity may locally exceed the 7,500 ppm threshold. Local effects on water quality may be high-intensity but would dissipate quickly with distance from the activity, with duration dependent upon water temperature, salinity, and current speed. Effects on water quality resulting from increased turbidity would be local and would generally be restricted to the areas within 100 m (328 ft) of the drilling or anchor handling activity (NRC, 1983; Neff, 2005). Effects resulting from increased turbidity would be temporary and expected to end within a few days after drilling or anchor handling activity stops. Anticipated effects from pipeline construction would have similar results in turbidity from trenching and burying of pipelines during construction.

As a result of the physical and chemical heterogeneity of typical drill cuttings and drilling fluids, the mixture would undergo fractionation (separate into various components) as it is discharged to the ocean. The larger particles, which represent about 90% of the mass of drilling mud solids, would settle rapidly out of solution, whereas the remaining 10% of the mass of the mud solids consists of fine grained particles that would drift with prevailing currents away from the drilling site (Neff, 2005; Neff et al., 2010). The fine-grained particles would disperse into the water column and settle slowly over a large area of the seafloor. Models, lab-scale simulations, and field studies suggest that discharged drilling muds and cuttings would be rapidly diluted to very low concentrations, and that suspended particulate matter concentrations would drop below effluent limitation guidelines within several meters of the discharge (Neff, 2005; Netto, Fonseca, and Gallucci, 2010). In well-mixed waters, particles discharged to the ocean from drilling activities are typically diluted by 100-fold within 10 m (33 ft) of the discharge and by 1,000-fold after a transport time of about 10 minutes at a distance of about 100 m (328 ft) from the platform (Neff, 2005). Material discharged during drilling and construction activities from the seafloor would be similar in composition to naturally-occurring seafloor sediments, and its contribution to turbidity from waves and currents would be about the same as the sediments existing at the seafloor surface before drilling activities (USDOI, BOEM, 2012). Experiments have shown the composition of deposited materials have an effect on recolonization of benthic communities, with natural sediments from disturbance of the benthic surface having less adverse effect on the recolonization rate than drilling muds, and water based drilling muds having less effect than synthetic muds (Trannum et al., 2011).

A previous exploration drilling operation on the Burger prospect was estimated to have disturbed 1,018 ft^2 of seafloor per well and each well cellar excavated 619 yd^3 of sediment (USDOI, BOEMRE, 2011g). Cuttings from the well cellar excavation were deposited on the seafloor below the temperature and salinity stratification layer. It is estimated that the maximum thickness of the sediment deposition onto the seafloor would be 10.4 ft (3.2 m) and the deposition would continue out to a horizontal distance of 449 ft (137 m) from the excavation site, where it would be 0.4 in (1 cm) thick. The excavation of a mud line cellar in a season would increase sediment, suspended solids, and turbidity in the lower water column above background levels, dependent upon the mineralogy and grain size of the sediments excavated. Currents and severe storm events could re-suspend and transport these newly deposited seafloor sediments (USDOI, BOEMRE, 2011g). After the disturbance of benthic surfaces ceases, it could take 4-8 years for invertebrate populations of species such as clams and other shellfish, used by marine maammals such as walrus, to recolonize. It could take from 1-2 years for smaller invertebrates, such as polychaetes, copepods, and amphipods, to recolonize.

As described above, in well-mixed waters, particles discharged to the ocean from drilling activities are typically diluted by 100-fold within 10 m (33 ft) of the discharge and by 1,000-fold after a transport time of about 10 minutes at a distance of about 100 m (328 ft) from the platform (Neff, 2005). Discharge of water-based drilling muds and drill cuttings in the surfacewater layer would create a plume of suspended material and turbidity. The ensuing downstream plume from cuttings dispersed into water is normally 10s of meters wide and 100-900 m (328-2,953 ft) long. However, the As described above, in well-mixed waters, particles discharged to the ocean from drilling activities are typically diluted by 100-fold within 10 m (33 ft) of the discharge and by 1,000-fold after a transport time of about 10 minutes at a distance of about 100 m (328 ft) from the platform (Neff, 2005). Discharge of water-based drilling muds and drill cuttings in the surfacewater layer would create a plume of suspended material and turbidity. The ensuing downstream plume from cuttings dispersed into water is normally 10s of meters wide and 100-900 m (328-2,953 ft) long. However, the he EPA uses the model results when considering issuance of NPDES permits (EPA, 2012c). Typical effects of surfacewater and bottom water discharges are presented in Table 4-8.

In addition to muds and cuttings, exploration activities would generate wastewater that would need to be discharged. It is estimated, based on industry Notices of Intent (NOI) submitted to EPA, that exploration wastewater would be discharged through a caisson at less than 10 m (33 ft.) below the sea surface; at this depth, wastewaters would typically discharge above the temperature-salinity gradient, where it would mix with surface waters.

Desalination brine, which contains a slightly higher salinity and slightly higher dissolved constituents than seawater, would be discharged to the surfacewaters. Domestic wastewater and treated sanitary waste would introduce organic materials that would increase suspended solids and turbidity, and could cause temporary localized biological oxygen demand.

Table 4-8. Oil and Gas Operations and Vessel Discharge Effects on Water: Various Depths.

Discharge Effects in the Marine Environment at Various Depths	Surface water	Mid water	Bottom water	Seafloor Sediments
Suspended sediment and suspended solids increase	x		x	
Dissolved solids and dissolved salts increase	x			

Discharge Effects in the Marine Environment at Various Depths	Surface water	Mid water	Bottom water	Seafloor Sediments
Contaminants introduced (metals, biocides, corrosion inhibitors, surfactants, detergents, residual chlorine, etc.)	x	x	x	x
Hydrocarbons introduced – soluble and insoluble fractions (small fuel spills, produced waters, deck drainage, etc.)	x			
Nutrients increase	x			
Turbidity increase	x	x	x	
Elevated temperature	x			
Elevated salinity	x			
Dissolved oxygen decrease (biological oxygen demand)			x	x
Coliform bacteria, and other pathogens introduced	x	x	x	
Marine invasive species – potential for introduction	x	x	x	x

Notes: [1]Surface Water and Sea Ice (surface to ~10 m (33 ft) depth); Midwater (~10 m to ~ 3 m (33-9.8 ft) above seafloor); Bottomwater (up to ~3 m (9.8 ft) above seafloor); Seafloor Sediments (to 1 m (3.2 ft) below seafloor)

Discharges would be permitted under NPDES or other applicable authorities.

Vessels greater than 79 feet in length operating as a means of transportation during exploration, development, production, and decommissioning activities in the territorial seas would require NPDES permit coverage for their incidental discharges under the VGP. Although not to be enforced until 2017 due to a congressional moratorium, these EPA permits will establish effluent limitations to control materials that contain constituents in the waste streams resulting from the activities of these smaller vessels. Pollutant constituents in the VGPs may include nutrients, pathogens, oil and grease, metals, biochemical oxygen demand, variations in pH, suspended solids, aquatic nuisance species, and other toxic and non-conventional pollutants with toxic effects. In addition to complying with NPDES requirements, vessels discharging in the contiguous zone and ocean (seaward of the outer limit of the territorial seas) are subject to the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78), implemented by the U.S. Coast Guard pursuant to 33 CFR Part 151).

Wastewaters would also be discharged in estuarine and freshwater environments during onshore operations in all phases. Discharges associated with onshore activities (wastewater facilities, processing facilities, housing facilities, construction activities, pipeline installation, gravel extraction for pipeline and road, etc.) would operate under various discharge permits from the State of Alaska and other Federal agencies with authorities in those waters. The effects of discharges on lakes, ponds, rivers, and streams are described in the National Petroleum Reserve in Alaska Integrated Activity Plan and Environmental Impact Statement, Sections 4.5.4, 4.6.4, 4.7.4, and 4.8.4 (Surface and Groundwater Resources and Water Quality) (USDOI, BLM, 2012).

Water Withdrawals. In 2012, EPA added cooling water withdrawal to the NPDES Chukchi Sea Oil and Gas Exploration General Permit. The EPA describes their requirements for issuance of NPDES permits for water withdrawal in their document: Cooling Water Intake Structure Requirements Permit Numbers: Chukchi Sea Exploration General Permit (EPA, 2012f). The National Petroleum Reserve in Alaska Final Integrated Activity Plan and Environmental Impact Statement (USDOI, BLM, 2012) describes the potential effects of withdrawal on freshwater resources. Example volumes of cooling water and desalination withdrawals for exploration activities are presented in Table 4-9.

Table 4-9. Cooling Water and Desalination Water Withdrawals for Exploration.[1]

Water Withdrawals	1 Exploration Well	4 Exploration Wells (Example Year)	40 Exploration Wells (Full Scenario)
Cooling water withdrawal for exploration well (based on 38 days of operation /well)	9,348,281 ft^3	39,393,124 ft^3	373,931,240 ft^3
Desalination water withdrawal for exploration well (based on 38 days of operation /well)	25,967 ft^3	103,868 ft^3	1,038,680 ft^3

Water Withdrawals	1 Exploration Well	4 Exploration Wells (Example Year)	40 Exploration Wells (Full Scenario)
Total water withdrawals for cooling water and desalination water for exploration well (based on 38 days of operation /well)	9,374,248 ft^3	37,496,992 ft^3	374,969,920 ft^3

Notes: [1]Example Non-contact Cooling Water and Desalination Water Withdrawals for Exploration Drilling over 38 Days/Well.

Estimates of volumes of water withdrawals are based on Notice of Intent for exploration drilling in the Chukchi Sea submitted by a lessee to EPA, 2010.

1 bbl = 0.159 m^3 = 35 ft^3

Seawater would be withdrawn during exploration, development, production, and decommissioning activities, for non-contact, once-through cooling of equipment, evaporative cooling, dilution of effluent heat content, and for desalination for freshwater supplies. Seawater would also be withdrawn for various marine-based activities during production, development, and decommissioning phases.

Water would also be withdrawn from the nearshore environment, lakes, ponds, and rivers for onshore construction and maintenance activities. The State of Alaska has established water quality standards for designated uses of marine and fresh water (www.dec.state.ak.us/water/wqsar). In the exploration and development phase, winter construction of the overland oil pipeline is expected to begin. It is anticipated that this would be accomplished, at least initially, using ice road, ice pad, and ice bridge construction. Gravel road construction and maintenance may also be necessary and would necessitate water withdrawals. Potential effects from water withdrawals from ponds and lakes include reduced water levels, decreased flow among lake systems, disrupted flow, erosion, and decreased oxygen.

Habitat Alteration

The 2007 FEIS (Section IV.C.1.a) describes the effects of seafloor disturbance on water quality. The 2011 SEIS (Section IV.E.2) describes the effects of seafloor disturbance on water quality. These sections are summarized below.

Activities that would alter the seafloor, include anchoring of drillships and weighing anchor, pipeline construction, and well cellar excavation. These activities physically disturb the seafloor and also increase suspended sediments, organic particulate matter, and turbidity in the bottomwater. Sediment discharges from these bottom-disturbing activities require NPDES permits, as discussed above, except for the anchoring and weighing anchor by vessels. Anchoring/weighing anchor are not considered discharges that require an NPDES permit.

Based on previous exploration operations in the Chukchi Sea in 2012, Table 4-10 presents an estimate of the amount of surface area that would be disturbed for exploration anchoring and other activities.

Table 4-10. Approximate Surface Area (ft^2) Disturbed by Exploration Activities.

Surface Area Disturbance	Estimated Surface Disturbance by Exploration Wells (ft^2)		
	1 Well	4 Wells/year	40 Wells During Scenario
Anchoring of drillship	32,432 ft^2	129,728 ft^2	1,297,280 ft^2
Placement of jack-up rig	40,588 ft^2	1,623,520 ft^2	16,235,200 ft^2
Construction of a mudline cellar - Drill Bit or ROV Method	161,000 – 387,000 ft^2	644,000 -1,548,000 ft^2	6,440,000 – 15,480,000 ft^2

Notes: Estimates are based on previously received drilling plans.

1ft^2 = 0.093 m^2

Anchoring would also occur in estuarine and freshwater riverine delta areas and cause similar increased suspended material and turbidity effects. Installation of onshore pipelines, although raised above the ground, would cause disturbance and water quality effects when installed at stream, river, or pond crossings.

Potential for Introduction of Marine Invasive Species

As described below in Section 4.3.4.1 non-native species through environmental factors has been shown to occur in the waters of the Chukchi Sea. Data from the expedition of the Russian-American Long-term Census of the Arctic (RUSALCA) showed unexpectedly high numbers of non-native bivalve species in the southeastern Chukchi Sea (Sirenko and Gageav, 2007). Although not common, marine invasive species (as used here, invasive species are non-native species that result in harm) in other northern seas have occurred and can be used as a proxy for potential effects in the U.S. Chukchi Sea. Table 4-11 presents a listing of new publications that address the potential for marine invasive species to occur from OCS oil and gas activities and the potential effects on the marine environment. These studies are fully described in Section 4.3.5.

Table 4-11. Marine Invasive Species Literature Published since the 2007 FEIS.

Potential for Marine Invasive Species: Topic Addressed	Date	Author, Publication
Oil rigs and associated equipment can be vectors for invasive species given the many niche areas and the slow speed of a rig towed in water	2009	Commonwealth of Australia
Potential pathways for and effects of invasive species associated with oil and gas equipment and activities	2010,	International Association of Oil and Gas Producers
Semisubmersible oil platforms are notable vectors for transporting non-indigenous species across biogeographical boundaries	2010	Yeo et al.
Non-native species on slow-moving vessels (barges and tugboats) most fouled in niche areas of the hull and where the anti-fouling paint condition was poor	2010	Hopkins and Forrest
Jack-up rigs as potential vectors for marine invasive species; dry-docking may mitigate potential of live organisms	2012	URS Alaska
Emergence of new Arctic trade routes will probably change the global dynamics of marine invasive species, especially in coastal regions	2014	Miller and Ruiz
Underwater vessel noise may promote settling of biofouling organisms	2014	McDonald et al.
Risk of ballast-borne marine invasive species to coastal Alaska	2014	Verna
Patterns of biological invasions in marine polar ecosystems	2009	Ruiz and Hewitt
Non-native colonial tunicate introduced to Alaska likely via previously used out-of-state dock and pier timbers, or ballast water discharge	2011, 2012	Cohen et al., Simkanin et al.
Non-native Chinese mitten crab discovered in the White Sea, Russian Arctic	2010	Pettersen
Non-native red king crabs introduced to Russian Barents Sea aggressively expands, preys on and competes with native species	2005	Jørgensen
Highly adaptive non-native green crab northward movement via intracoastal ship ballast water discharges have established in British Columbia	2005	Jamieson et al.

Note: Summary of literature published since the 2007 FEIS that addresses the potential for marine invasive species to occur and the potential effects on the marine environment.

Accidental Oil Spills (Exploration)

Small Refined Oil Spills (Exploration)

Small refined oil spills (<1,000 bbl) have the potential to occur during open-water season in the exploration phase. Small spills onboard a vessel or on a platform may be contained. Small spills reaching the water may be contained in the water by booms or absorbent materials. The impacts to water quality from small refined oil spills include contamination of the surface water and potential short-term levels of toxicity in the immediate vicinity of the small spills.

Development

Development activities would affect various water resource environments (marine, estuarine, freshwater) and at different depths. Effects from development or exploration wells are expected to be similar. Activities in the development phase that would affect water resources are presented in Table 4-12.

Table 4-12. Development Activity Types and Water Resource Environments Affected.[1]

Type of Development Activity that Would Affect Water Resources	Environment and Depth[2] Affected – Development			
	Marine: Surface Water, Ice	Marine: Midwater Column	Marine: Bottomwater and Seafloor Sediments	Estuarine and Freshwater
Discharges from development activities				
Installation of offshore platforms	x	x	x	
Drilling for production and service wells	x	x	x	
Installation of offshore oil pipeline and gas pipeline	x	x	x	
Installation of onshore oil pipeline and gas pipeline				x
Construction-shorebase, processing and waste facilities				x
Vessel discharges	x	x	x	x
Seawater, estuarine and freshwater withdrawals	x	x		x
Accidental refined or crude oil spills < 1,000 barrels	x			x
Accidental large oil spills, ≥1,000 bbl	x	x	x	x

Notes: [1]Type of Development Activity and the Water Resource Environments Affected by the Activity.
[2]Surface Water and Sea Ice (surface to ~10 m (33 ft) depth); Midwater (~10 m to ~ 3 m (33-9.8 ft) above seafloor); Bottomwater (up to ~3 m (9.8 ft) above seafloor); Seafloor Sediments (to 1 m (3.2 ft) below seafloor).

Development activities are permitted under an NPDES Individual Permit for each operation. The Individual Permit is specific to the type of activities and discharges at that operation.

The effects of the impact producing factors described in the exploration phase (discharges, habitat disturbance, water withdrawals, small refined oil spills, and potential for marine invasive species) also occur in the development phase. The effects of these activities are presented above. In the development phase, accidental small crude oil spills, small condensate spills, and large oil spills could occur.

Accidental Small and Large Oil Spills

Development activities would present the potential for small refined spills, small crude spills, small condensate spills, and large (≥1,000 bbl) oil spills.

During development, small refined spills, small crude oil spills, and small condensate spills could occur any time of the year. The effects of a small refined spill are analyzed under exploration. A small crude oil spill or condensate spill during open water would introduce hydrocarbon contaminants of various weights into the surface water, causing a temporary decrease in water quality and conditions for potential toxicity. Lighter weight hydrocarbon fractions (such as condensates) would volatilize more rapidly than heavier hydrocarbon fractions; however, lighter weight fractions on the water surface would present greater potential for toxicity for surface-dwelling organisms. During ice season, these small crude oil and condensate spills would potentially affect the localized surface quality of ice and surface water quality if the spill occurred in broken ice.

Large crude oil spill(s), large condensate spills, and large diesel spills could potentially occur during development. These spills could affect marine surface waters, coastal waters, and tidal riverine waters. The chemistry of sea water changes at the surface continuously as an oil spill on the surface changes. Individual hydrocarbon compounds at the surface of an oil spill would decrease in concentration through volatilization and other processes, depending on the weight of the hydrocarbon compound. Dissolution and accumulation of hydrocarbon compounds in the water underlying the oil would occur in a large oil spill. Concentrations of dissolved oil that move from the surface water into the water column could then spread horizontally in the water column.

Production

Production activities would affect various water resource environments (marine, estuarine, freshwater) and at different depths. Activities in the production phase that would affect water resources are presented in Table 4-13.

Table 4-13. Production Activity Types and Water Resource Environments Affected.[1]

Type of Production Activities that Would Affect Water Resources	Environment and Depth[2] Affected - Production			
	Marine: SurfaceWater, Ice	Marine: Midwater Column	Marine: Bottomwater and Seafloor Sediments	Estuarine and Freshwater
Oil production discharges	x	x	x	
Gas production discharges	x	x	x	
Vessel discharges	x	x	x	x
Pipelines offshore – transport of oil and gas	x	x	x	x
Pipelines onshore – transport of oil and gas				x
Seawater, estuarine and freshwater withdrawals	x	x		x
Accidental refined or crude fuel spills < 1,000 barrels	x			x

Note: [1]Type of Production Activity Types and the Water Resource Environments Affected by the Activity.
[2]Surface Water and Sea Ice (surface to ~10 m (33 ft) depth); Midwater (~10 m to ~ 3 m (33-9.8 ft) above seafloor); Bottomwater (up to ~3 m (9.8 ft) above seafloor); Seafloor Sediments (to 1 m (3.2 ft) below seafloor).

The effects from impact producing factors described in the exploration phase (discharges, seafloor disturbance, water withdrawals, small refined oil spills, and potential for marine invasive species) also occur in the production phase. In addition, accidental small crude oil spills, accidental small condensate spills, accidental large oil spills, and natural gas releases could occur during the production phase. Discharges from development or production activities would be subject to environmental review and permitting under the Clean Water Act.

Decommissioning activities (part of the production phase) would affect various water resources (marine, estuarine, freshwater) and at different depths. Activities during decommissioning that would affect water quality are presented in Table 4-14. The effects of decommissioning activities on water quality would primarily result from discharges and accidental small refined or crude oil spills.

Table 4-14. Decommissioning Activity Types and Water Resource Environments Affected.[1]

Type of Decommissioning Activity that Would Affect Water Quality	Environment and Depth[2] Affected - Decommissioning			
	Marine: Surface Water, Ice	Marine: Midwater Column	Marine: Bottom-water and Seafloor Sediments	Estuarine and Freshwater
Discharges associated with the following actions:				
Oil and gas wells plugged			x	
Wellhead equipment removal	x	x	x	
Processing module removed from platforms	x			
Platform disassembled	x	x	x	
Offshore pipelines decommissioned, plugged			x	
Seafloor restoration			x	
Onshore pipelines remain in place				x
Vessel discharges	x	x	x	x
Seawater, estuarine, and freshwater withdrawals	x	x		x
Accidental refined or crude fuel spills < 1,000 barrels	x			x

Note: [1]Type of Decommissioning Activity and the Water Resource Environments Affected by the Activity.
[2]Surface Water and Sea Ice (surface to ~10 m (33 ft) depth); Midwater (~10 m to ~ 3 m (33-9.8 ft) above seafloor); Bottomwater (up to ~3 m (9.8 ft) above seafloor); Seafloor Sediments (to 1 m (3.2 ft) below seafloor).

Accidental Small and Large Oil Spills and Gas Releases

Small refined oil, crude or condensate spills could occur during production. Large spills of crude oil, condensate or diesel (≥1,000 bbl) could also occur during production. Gas releases at offshore operations and onshore gas pipeline are possible during the oil and gas production phase.

In the event of a natural gas release, methane (CH_4) would be released into the water and proceed to rise through the water column as a function of depth of release (pressure), volume of release, rate of release, water temperature, and ice presence or absence. When released in a blowout or rupture at depth, the water quality would be altered temporarily. In deeper, colder waters, some of the natural gas would enter the water as a water-soluble fraction. Upon reaching the surface the gaseous CH_4 would react with air, forming carbon dioxide (CO_2) and water which would then disperse into the atmosphere. The higher concentration of CO_2 near the surface would affect chemical and biological processes and reactions at the water-air interface.

Impacts of the Scenario through Time

This section provides analysis of impacts to water resources as they occur through the 77 years of the Scenario. This analysis addresses the particular oil and gas activities that would occur during each phase and analyzes their impacts. In total, these sections describe how the activities comprising the Scenario would affect water quality through time. It is acknowledged that the analyses are conducted against the backdrop of a dynamic environment. The effects of climate change would be occurring simultaneously. Warmer air and water temperatures would result in earlier spring snowmelt, decreases in ice thickness during winter, and accelerated rates of erosion. In addition, changes in the acidity of the world's ocean are expected to continue. Consequently, during the life of the Scenario, there would be potential shifts in the environmental baseline.

Exploration (Years 1-5)

Water resources (marine, estuarine, and freshwater) would be affected during the exploration phase (Years 1-5) by discharges from exploration drilling, operations and vessels; anchoring; water withdrawals; potential for aquatic invasive species, including pathogens; and accidental small refined oil spills. During this phase, approximately 12 exploratory wells could be drilled by up to 2 MODUs resulting in the discharge of about 63,800 ft^3 (1,807 m^3) per well of drill cuttings, fluids, and sediment into the water; and disturbing about 387,000 ft^2 (35,953 m^2) per well of seafloor for construction of well cellars and anchoring. Four to twelve marine seismic, geohazard and geophysical surveys could be conducted, involving up to 3 vessels for each survey. These vessels would discharge gray and ballast water. Exploration activities would also require water withdrawals of approximately 9,375,000 ft^3 (265K m^3) per well.

In regard to discharges of muds and cuttings from exploration activities, effects on water quality are anticipated to be short-term and localized. Effects from drilling activities on deposition of metals would not vary from typical background levels, Monitoring programs using sediment and faunal sampling at sites near former exploratory wells and control collections have shown that effects from drilling activities on deposition of metals or chemicals are not additive. BOEM-funded studies (Chukchi Sea Offshore Monitoring Program in Drilling Area (COMIDA)-Chemical and Benthos (CAB)) have investigated the deposition of metals produced by exploratory drilling programs in the early history of exploratory activities in the region of the Leased Area. Fox et al. (2014) tested seawater, sediments, and faunal samples at 58 stations near sites of old exploratory wells. Also sampled were random reference sites within a 56 km (34.8 mi) grid surrounding the drill sites to understand natural environmental background levels. Benthic surface sediments and sediment cores were concurrently collected and tested for anthropogenic input of metals due todrilling activities (Trefry et al., 2014). A suite of 17 metals, including mercury, copper, barium, and lead, were tested for their concentrations in sediments. Analysis found concentrations of metals varied throughout the

Leased Area due to natural variation in sediment texture and grain size, but with few exceptions were shown to be consistent with naturally occurring levels. These exceptions were from surveys around two exploratory oil and gas drilling sites that were occupied in 1989 showing that barium concentrations were as high as 10,000 µg g−1 within 200 m of one drilling site relative to background values of ~700 µg g−1. Barium enrichment was from barite, a drilling mud additive that was discharged to the seafloor. Above background concentrations of copper, mercury, lead, and zinc also were found in sediments from 3–4 stations within 200 m of the same two drilling sites. They found no meaningful statistical differences in mercury in water or sediments between the samples collected. faunal samples tested included amphipods, clams, snow crab (*Chinoecetes opilio*), and Arctic cod. Laboratory results showed minimal evidence of elevated mercury or biomagnification when compared to background mercury levels within this range of organisms. Overall, at the sites tested, sediments in the Leased Area were essentially unaffected with respect to trace metals of anthropogenic origin, excluding small areas nearby two drilling sites.

In addition to discharging muds and cuttings, vessels (i.e., MODUs, seismic survey vessels, and support vessels) discharge waste, cooling, and desalination waters into the surrounding waterbody. Water is also withdrawn for cooling. As described above, it is anticipated that exploration wastewater would be discharged at a depth where it would mix with surface waters. For cooling waters, it is estimated that 45,000 barrels (252,656 ft^3) of cooling water per MODU per day would be discharged at approximately 1-2°C (1.8-3.6 °F) above ambient sea temperature at or very near the sea surface. It is estimated the temperature effect would dissipate within 50 m (164 ft.) horizontally depending on several factors including: temperature above ambient, volume of discharge, rate of discharge, and degree of mixing in the discharge area (along current direction and speed) (EPA, 2012d). Desalinaiton brine would also be discharged to surface waters. Overall, it is anticipated that discharging waste, cooling, and desalination waters, as well as withdrawing coolant or desalination waters, would have negligible temperature and salinity effects as permitted and regulated under current NPDES permits.

Small refined-oil spills (<1,000 bbl) could occur during exploration activities. These spills could result from refueling activities at sea during geological and geophysical activities (geohazard, geotechnical or marine seismic surveys), during exploration drilling activities, or during construction of exploration bases on land. The estimated total, as well as the annual number and volume of small refined oil spills during exploration activities are displayed in Tables 4-1 and 4-2.

A summary of the effects of small refined spills (<1 to 50 bbl) on water quality during Years 1-5 of the Scenario includes:

- A small refined spill would introduce hydrocarbons to the surface of marine, coastal, tidal riverine, or fresh waters
- Water quality characteristics in the surface layer in the immediate area of the spill would be degraded for hours up to three days (Tables A.1-24 and A.1-25)
- Hydrocarbon compounds could dissolve and accumulate in water underlying the spill depending on environmental conditions
- Hydrocarbon concentrations could cause conditions of toxicity for biota dwelling in the surface water

During this phase, the primary effects on water quality would result from discharges and small refined oil spills. As discussed above, discharges (muds/cuttings, sediment, and water) that would occur during the exploration phase would be short-term, and localized. Such discharges would also be regulated by the EPA and are required to meet Federal and state standards for the protection of water quality and the marine environment. Therefore, effects on water quality resulting from turbidity from discharged drill cuttings and drilling fluids are expected to be temporary, and localized to the vicinity of the discharge. The introduction of aquatic invasive species during these years is a potential adverse impact, although during these years, there would be fewer vessels and other equipment operating in the area than in subsequent years. Overall, the effects from activities in Years 1-5 would be short-term and localized, and thus would be considered minor.

Exploration and Development (Years 6-9)

Exploration activities during this period would continue in the same manner and frequency as during the preceding period, with potential impacts as described above. This period also includes development activities that include production well drilling, exploration and delineation well drilling, installation of an offshore platform, and installation of offshore and onshore pipelines. Approximately 257.50 km (about 160 mi) of pipelines are proposed for burial in the seafloor. The width of the offshore pipeline trenches is estimated to be approximately 3 m (~10 ft) and the depth is estimated to be 3.5 m (~11.5 ft). Trenching will occur during open-water season at a rate of approximately 40 miles per year. One mile of pipeline, depending upon sediment type (ratio of sand, mud, gravel, etc., in any specific stretch of the pathway), would be approximately 55,400 m^3 (596,751 ft^2) of sediment let into the water column and deposited upstream of currents. Considering the strong northward current flow (see Section 3.1.3, Physical Oceanography) of both the prevailing central channel current and Alaska coastal current, the effects of sedimentation deposition would be localized and temporary to water quality.

The effects on water resources (marine, estuarine, and freshwater) are similar to those described above. There would be discharges of muds, cuttings, sediment, gray and ballast water from operations and vessels, anchoring, and pipeline trenching. There would also be water withdrawals, and the potential for aquatic invasive/exotic species, including pathogens, accidental small refined oil, and crude oil spills.

As described above (Years 1-5), effects from drilling activities on deposition of metals would not vary from typical background levels, as evidenced by testing through monitoring programs using sediment and faunal sampling at sites near former exploratory wells and control collections. At the sites tested, sediments in the Leased Area were essentially unaffected with respect to trace metals of anthropogenic origin, excluding small areas nearby drilling sites.

Effects on water quality resulting from increased turbidity would be local and would generally be restricted to the areas within 100 m (328 ft) of the drilling or anchor handling activity (NRC, 1983; Neff, 2005). Increased turbidity would also be expected to end within a few days after drilling or anchor handling activity stops. Anticipated effects from pipeline construction would have similar results in turbidity from trenching and burying of pipelines during construction.

The potential for small refined spills (<1,000 bbl) continues in the exploration and development phases (e.g. facility construction and operation, and pipeline installation), and there is a potential large spill. The effects of small refined spills are described above under Years 1-5. During Years 6-9, there would be an increased number of small spills compared to Years 1-5, but a decrease in the estimated average size of a small spill.

Impacts from all activities, including oil spills, could be detectable, long lasting and widespread, but less than severe. Consequently, the impacts on water resources over all activities in Years 6-9 could be moderate.

Exploration, Development, and Production (Years 10-25)

This time period includes the same aspects of exploration and development as analyzed in previous sections above. Exploration drilling continues, and five marine seismic surveys and one geotechnical survey during this period, and impacts from that activity are considered. There is a small amount of periodic construction activity associated with platform installation. Meanwhile, production activities commence, to include the operation of up to four drilling units, offshore platforms, and associated pipelines.

Water resources (marine, estuarine, and freshwater) would be affected during the exploration, development, and production phases during Years 10-25 by: discharges from operations and vessels; anchoring; pipeline trenching; water withdrawals; potential for aquatic invasive species, including pathogens; accidental small refined and crude oil spills; and large oil spill(s). Small (<1,000 bbl) oil spills could occur during exploration, development, or production. Several hundred small oil spills are assumed to occur during the 77-year Scenario. In Year 10, as oil development and production begin in earnest, large (≥1,000 bbl) oil spills could occur. It is assumed that two large oil spills could occur during the entire life of oil development and oil production activities.

Small Oil Spills

Section 4.1.2.5 (subsection on Small Oil Spills) and Tables 4-1 and 4-2 describe the assumptions about small oil spills. Years 10- 25, however, would add 6 more small refined spills per year (3 bbl each) than was described under Years 1-5.

During Years 10-25, small refined oil spills, small crude oil spills, and small condensate spills, could occur at any time of the year. The effects of small refined spills are described above under Years 1-5. Two small crude oil spills (≥500 bbl and <1,000 bbl) are estimated to occur. Of these two small crude oil spills, one is assumed to occur offshore, and one is assumed to occur from the 300 mi onshore pipeline.

A small crude oil spill or condensate spill at sea during open water would introduce hydrocarbon contaminants of various weights into the surface water, causing a temporary decrease in surface water quality and cause conditions for potential toxicity to surface-dwelling biota; lighter weight hydrocarbons generally cause greater toxicity.

Lighter-weight hydrocarbon fractions (such as condensates) would volatilize more rapidly than heavier hydrocarbon fractions (crude or refined). Light-weight hydrocarbon fractions, though existing for a shorter time on the sea surface, would present a greater potential for acute toxicity for surface-dwelling biota. During ice season, small spills would introduce contaminants on to the sea ice, and into surface water if the spill occurred in broken ice. The effects of a small crude spill or small condensate spill on water quality would be similar to those described for small refined spills, however, crude oil could persist longer than refined spill, and condensate would have greater toxicity than a refined spill.

A small crude spill from an onshore pipeline could enter freshwaters through a stream, pond system, or wetland, causing a diminishment of water quality, potential toxicity to biota, and possible persistence in low velocity waters, such as a pond.

Large Oil Spills

Section 4.1.2.5 (subsection on Large Oil Spills) and Table 4-3 describe the assumptions for a large oil spill(s). The assessment of large oil-spill impacts are based on a combination of factors, including the oil type, spill size, spill duration and weathering, the paths (trajectories) the spill(s) follow, and the probability of one or more large spills occurring. Appendix A further describes the many facets of large oil-spill assessment.

For purposes of analysis of the effects on water quality, the larger of the two large spill volumes was chosen. The weathering characteristics of the assumed 5,100-bbl oil spill in summer and during meltout are shown in Tables A.1-4 A.1-5, and A.1-7, respectively.

Two large spills—of 1,700 bbl crude or condensate oil from a pipeline, and 5,100 bbl crude, diesel or oil condensate from a platform—could potentially occur during development. These spills could affect marine surface waters, coastal waters, and tidal riverine waters (Table 4-3). The chemistry of the sea water surface changes continuously as an oil spill on the surface changes. Individual hydrocarbon compounds at the surface of an oil spill would decrease in concentration through volatilization and other processes, depending on the weight of the hydrocarbon compound. In a large oil spill, hydrocarbon compounds could dissolve and accumulate in the water underlying the oil. Concentrations of dissolved oil that move from the surface water into the upper water column could then spread horizontally in the water column. Oil that becomes mixed in the water column could deposit to the bottom sediments, degrading the sediment and bottom water quality.

A summary of the effects of large crude, condensate, or refined oil spills (≥1,000 bbl) on the quality of marine, coastal, and tidal riverine waters during Years 10-25 of the Scenario includes:

- A large oil spill would introduce hydrocarbons to the surface of marine, coastal, tidal riverine, and fresh waters
- Water quality characteristics in the surface layer would be degraded depending on conditions (Tables A.1-4 through A.1-8, inclusive)
- Hydrocarbon compounds could dissolve and accumulate in water underlying the spill depending on prevailing environmental conditions
- Hydrocarbon concentrations would cause conditions of toxicity for biota dwelling in the surface water
- Weathered oil mixed into the water column could be deposited in bottom sediments
- A large crude oil spill on to ice could drift and affect water quality in a different area when melt occurs
- Two large spills reaching coastal waters or tidal riverine waters in Years 10-25 could cause long-term degraded water quality

Large condensate and diesel fuel spills would evaporate and disperse generally within 1-13 days. A large crude oil spill, however, is estimated to persist much longer: after 30 days 28-40% would evaporate, 3-16% would disperse, and 44-62% would remain (Table 4-3). A large crude oil spill from a platform (5,100 bbl) into open water would cover an estimated discontinuous area of 54 km^2 after 3 days and 1,063 km^2 after 30 days A large crude oil spill from a platform on to the ice surface during November through May would cover an estimated discontinuous area of 18 km^2 after 3 days and 351 km^2 after 30 days (Appendix A, Table A.1-7). A large crude oil spill from an offshore pipeline (1,700 bbl) during open water would cover an estimated discontinuous area of 31 km^2 after 3 days and 615 km^2 after 30 days. A large crude oil spill from an offshore pipeline on to the ice surface during November through May would cover an estimated discontinuous area of 10 km^2 after 3 days and 200 km^2 after 30 days. Oiled ice that drifts and subsequently melts during open water would introduce oil into surface waters in new areas (Appendix A, Table A.1-8).

Coastal waters where there is limited mixing (due to hydrography and lower current velocity) would likely have greater diminishment of water quality than open marine waters, especially during a period of rapid ice growth that could leach water-soluble aromatics into the sinking brine waters. Climate change effects will be gradual and persistant, with changes in water chemistry and increased wave energy from less ice and increased open water, and increased weather activity from weather patterns, creating a changing environment resulting in an increase of chances for introduced species and changes in abundance and diversity of biota. As stated above, the effects of climate change would be occurring simultaneously and could potentially shift the environmental baseline.

Oil-Spill Response

An oil-spill response plan would be required prior to exploration or development and production activities (30 CFR 254). Oil-spill response could reduce the effects of an oil spill on water quality through containment and cleanup. During oil-spill-response activities, water quality could be affected by an increase in the number of vessels operating and the associated vessel discharges, and small refined spills associated with the response operations.

Development and Production (Years 26-50)

Development and production activities during this period would continue in generally the same manner and frequency as during the preceding period, as analyzed above. This period includes construction of a satellite field and continuation of oil production. Construction activities would include installation of two additional production platforms and several offshore pipelines

Water resources (marine, estuarine, and freshwater) would be affected in the same manner as described above. During the development and production phases in Years 26-50, there would continue to be discharges from operations and vessels, anchoring, pipeline trenching, water withdrawals, potential for aquatic invasive species, accidental small refined and crude oil spills; and large oil spill(s).

Small spills (<1,000 bbl) and large (≥1,000 bbl) spills could occur during development and production. Two large spills are assumed to occur during the entire life of development and production.

The production of gas for sales in Year 31 increases the potential for a large volume gas release. The effects of a release of dry gas on water quality are analyzed in the 2011 SEIS (Section IV.C.1). The same assumptions, related to a natural gas release in the 2011 SEIS, also apply here. The exception is that this analysis also assumes one additional gas release from an onshore pipeline.

In the event of a natural gas release at sea, methane would be released into the water and proceed to rise through the water column as a function of depth of release (pressure), volume of release, rate of release, water temperature, and ice presence or absence. When released in a blowout or rupture at depth, the water quality would be altered temporarily. In deeper, colder waters, some of the natural gas would enter the water as a water-soluble fraction. Upon reaching the surface, the gaseous CH_4 would react with air, forming CO_2) and water which would then disperse into the atmosphere. The higher concentration of CO_2 near the surface would affect chemical and biological processes and reactions at the water-air interface.

A gas release from an onshore above-ground pipeline would not affect water quality of ponds, streams, and wetlands in the area of the release.

Impacts from all activities, including oil spills, would be detectable, long lasting and extensive, but less than severe. Consequently, impacts on water resources over all activities in Years 26-50 would be moderate.

Production and Decommissioning (Years 51-77)

Production activities in this phase will continue but oil production would shift to gas production. No additional construction or seismic survey activities are anticipated. The removal of these production platforms would begin in Year 60. There is also a period (Years 54-65) of additional drill rig activity for the purpose of plugging and decommissioning of the subsea wells.

Water resources (marine, estuarine, and freshwater) would be affected in the same manner as described above in Years 51-77 by: discharges from operations, inducing produced waters; discharges from vessels; water withdrawals; potential for aquatic invasive species, including pathogens; accidental small refined and crude oil spills; and large oil spill(s).

Small (<1,000 bbl) and large (≥1,000 bbl) crude, condensate or diesel spills could occur until Year 53, when crude oil and condensate production ends. Large diesel spills and gas releases could occur through Year 74. Refined small spills could occur through Year 77.

The effects of small refined spills on water quality are described above under Years 1-5. The effects on water quality of small crude spills, small condensate spills, large oil spills, and gas releases are described above under Years 10-25.

Impacts from all activities during this phase, including oil spills, would be detectable, long lasting and widespread, but less than severe. Consequently, impacts on water resources over all activities in Years 51-77 would be moderate.

Conclusion

Considering effects on water resources from all activities in Years 1-77, the impacts on water quality from routine oil and gas activities associated with the Scenario would be minor because potential adverse effects would be localized and short-term. In the event of one or more large oil spills, effects would be moderate because they could be widespread, and long-lasting. As stated above, however, the effects of climate change would be on-going. As a result, ocean acidification and other shifts in the environmental baseline may interact with anticipated effects of the Scenario on water resources. The inclusion of mitigation measures, as described below, would serve to minimize potential adverse impacts to water resources.

Mitigation Measures

The effects of the Scenario on water quality may be modified by application of mitigation measures. The EPA issues both general and individual NPDES general permits for a variety of discharge into Federal waters. The EPA models the potential effects of the discharges based on project-specific features including water depth, depth of discharge, rate of discharge, and current speed and direction. If a permit is issued, the permits contain specific stipulations that minimize impacts to water quality. The State of Alaska has been delegated authority in state waters, and issues Alaska Pollutant Discharge Elimination System (APDES) permits in a similar manner as EPA. In addition, an oil-spill-response plan would be required prior to exploration or development and production activities (30 CFR 254). The effects of small spills to water quality, and other resources, would be minimized by requirements such as spill-catchment equipment on vessels, exploration rigs, and at land facilities; deployment of booming equipment during offshore fuel transfers; and automatic shutdown of fuel lines triggered by decreased pressure.

4.3.1.2. Alternative II – No Action

If Lease Sale 193 were not affirmed, water quality would not be affected by the various discharges and water withdrawals associated with the lease sale's potential oil and gas exploration, development, and production activities. There would also be less freshwater, estuarine, and marine aquatic habitat disturbance and subsequently reduced suspended sediments introduced. The possibility of introducing aquatic invasive species would be reduced.

4.3.1.3. Alternative III – Corridor I Deferral

Alternative III provides the largest deferral area of the action alternatives – a corridor approximately 60 miles (97 km) wide along the Chukchi Sea shoreline. If Alternative III were selected, the distance from the shore to many activities could be greater than under Alternatives I and IV. No exploration or development drilling or platform construction would occur within the corridor, although certain activities (i.e., installation of a pipeline extending from the leases outside the corridor to the shore) could occur there. Of the Lease Sale 193 leases, only five are within Corridor I.

The minimum distance from shore under Alternative III could be slightly greater for the following than under the other action alternatives: length of pipeline from a platform to shore; travel distances from vessels and aircraft; source of discharges, emissions and noise from drilling and platforms; and, potentially the source of a large OCS oil spill.

Slightly greater adverse impacts to water quality could occur under Alternative III than under the other action alternatives due to more trenching, longer excavation times, greater seafloor disturbance, and longer water/sediment suspension times. Because many activities could not occur in the corridor, however, some localized discharges to marine waters may be prevented under this alternative. Using the Impacts Scale in Section 4.2, the level of impacts under Alternative III would be consistent with the other action alternatives.

4.3.2. Air Quality

Air quality can be affected by oil and gas activities that result in the discharge or evaporation of pollutants into the air (collectively referred to hereinafter as emissions). This section analyzes and evaluates the potential effects to air quality resulting from activities described in the Scenario provided in Appendix B, Table B-7. The existing condition of air quality on the North Slope is described in Chapter 3, Section 3.1.7.

4.3.2.1. Alternatives I and IV

Impact Producing Factors

This section identifies the IPFs associated with oil and gas exploration, development, production, and decommissioning phases that would affect air quality. IPFs are organized by phase of oil and gas activity (i.e. exploration, development, and production). IPFs which are expected to occur during multiple phases of the Scenario are addressed in the phase in which the IPF first appears. Accidental oil spills, though not considered a routine oil and gas activity, have the potential to occur during each phase of oil and gas operations.

Two IPFs are relevant to the analysis of air quality impacts:

- Emissions from engine exhaust, particularly diesel-powered engines, resulting from the routine operation of vessels, MODUs, aircraft, onshore infrastructure, and other equipment associated with the Scenario, as well as onshore and offshore construction
- Evaporative emissions from accidental oil spills and natural gas releases

Emissions

The air quality analysis focuses on the principal and most consistent source of projected emissions - engine combustion, and specifically diesel-powered engines. When powered by diesel fuel (distillate oil), as most engines will be under all phases of the Scenario, the primary emissions will be nitrogen oxides (NO_x) and carbon monoxide (CO). Once released into the atmosphere, behavior of the pollutants will vary given the type of source (stationary or mobile), the spatial location of the sources relative to land, sea, and air, and temporal characteristics of the source throughout the Scenario.

Emissions from Mobile Sources

Mobile sources are more difficult to evaluate than stationary sources. Stationary sources have a steady or nearly steady exhaust from a fixed location, whereas mobile sources do not emit a steady exhaust; their exhaust is instead relative to the thrust setting and power rating of the individual engine; nor are they operated at a fixed location. Moving sources cause engine exhaust (plume) to be discharged over a distance, expanding the plume of pollutants both horizontally and vertically. The elongated plume is diluted (mixed with surrounding air) and diffused (plume continually expands throughout both vertical and horizontal planes), by atmospheric conditions as part of a process hereinafter referred to as dispersion. It is the effect of dispersion that decreases the ground-based impact of the emissions, the further downwind the pollutants are tracked.

Due to these factors, most mobile emissions from ships and boats, helicopters, and onshore vehicles associated with the Scenario will not have the opportunity to continuously or steadily impact any specific ground-based location such that increasing concentrations could adversely impact air quality there. Thus, the dispersion of emissions from a moving source makes the accumulation of pollutants less of a concern at any specific downwind location. In addition, the greater the distance between the sources and a given downwind location, the less the impact of the emissions to that downwind location, so that accumulation is less likely with increasing distance.

Emissions from diesel engines powering mobile sources are controlled at the point of manufacture per regulatory requirements. For instance, marine engine exhaust is controlled by agreements under the MARPOL 73/78 Annex VI International Convention for the Prevention of Pollution from Ships (40 CFR 1043.60(b)).

For ships, marine engines operate at several thrust levels during distinct operational modes, including idle, slow cruise, cruise, and maneuvering. During each operational mode, the engine is set at a different power rating for varying periods of time, meaning that the rate of emissions varies with each operational mode. This characteristic makes precise calculations of total emissions from vessels challenging.

In the case of helicopter or other aircraft emissions, the source moves horizontally and is elevated with respect to the ground. Aircraft emissions are unique compared to other mobile sources in that aircraft also ascend and descend through the atmosphere in addition to being operated at varied thrust settings. Emissions from aircraft operating at an altitude higher than 1,500 feet above sea level (during cruise) will not influence surface-based concentrations (Kadygrov et al. 1999). However, the approach, taxi, and landing-takeoff operations (LTOs), which occur at and near the surface, have many of the same emissions characteristics of other mobile sources and are considered in this analysis.

Emissions from Stationary Sources

Ships are considered mobile sources of emissions when they are underway and their main engines are used for propulsion. However, a ship or other drilling device associated with the Scenario can be considered a stationary source when the unit is anchored or otherwise attached securely to the sea floor. Other stationary sources associated with the Scenario are offshore production platforms, onshore infrastructure (e.g., base camps, bases, and terminals), and offshore and onshore pipelines. All types of offshore and onshore stationary sources associated with oil and gas operations emit pollutants each day for as long as the operation continues. Pollutants from stationary sources have the tendency to continuously affect the same downwind location, and thus have potential to deteriorate air quality at downwind locations more consistently than when compared to mobile sources.

Emissions from stationary sources are typically controlled by the operator as recommended by the manufacturer; for instance, operating diesel engines at 80% power to avoid wearing out the engine prematurely. This strategy is accounted for in the air quality analysis. Other potential strategies include after-market mechanical scrubbers and control devices, such as a Selective Catalytic Reduction (SCR) device. Such strategies were not included in this analysis of emissions from stationary sources or mobile sources but may in fact be utilized to further reduce emissions to comply with applicable regulatory requirements (see below).

Regulation of Emissions

Emissions from sources anticipated under the Scenario are regulated and may affect the calculation of annual emissions for this analysis. These are the BOEM Air Quality Regulatory Program (AQRP), the CAA National Ambient Air Quality Standards (NAAQS), and the International Convention for the Prevention of Pollution from Ships (MARPOL Annex VI). One or more of these regulatory requirements may affect potential emissions and impacts under the Scenario.

BOEM Air Quality Regulatory Program. OCS stationary sources are generally considered to have a greater impact on specific downwind locations than would offshore mobile sources, and for this reason they are the subject of regulatory control. Offshore stationary sources of emissions are regulated by either the EPA or BOEM, depending on the location of the source. On the Chukchi Sea OCS, emissions from offshore facilities (e.g. production platforms and MODUs attached/anchored to the seafloor) are regulated by BOEM.

BOEM's jurisdiction here is the product of a recent Congressional act.

On December 23, 2011, the U.S. Congress passed the Appropriations Act, 2012 (the Act) (Pub. L. 112-74). Under Sec. 432(b), the Act revises Section 328(a)(1) of the CAA (42 USC 7627(a)(1)) and restores pre-1990 jurisdiction for the control of OCS emission sources on the Alaska OCS adjacent to the North Slope Borough (Arctic OCS) to the Secretary, Department of the Interior. Further defining the Secretary's jurisdiction is the OCSLA, Section 5(a)(8) (43 USC 1334(a)(8)), which requires the Secretary to promulgate regulations "for compliance with the national ambient air quality standards pursuant to the CAA (42 USC 7401 et seq.) to the extent that activities authorized under this Act significantly affect the air quality of any State."

The Secretary, through BOEM, has established rules for Pollution Prevention and Control at 30 CFR Part 550 subpart C. These rules are referred to as BOEM's AQRP.The AQRP requires lessees proposing oil and gas plans on the Arctic OCS to demonstrate in their proposed EPs and DPPs that operation of their proposed facilities would not significantly affect the air quality of a state, and must demonstrate how the plan complies under 30 CFR 550 Subpart C.

The AQRP incorporates by reference many substantive air quality standards promulgated by EPA pursuant to EPA's CAA authority and responsibilities. For most CAA-regulated pollutants (i.e. CO, NO_x, sulfur dioxide (SO_2) and particulate matter (PM), defined as fine particles with an aerodynamic diameter of 2.5 micrometers or less ($PM_{2.5}$), and coarse particles with an aerodynamic diameter of 10 micrometers or less (PM_{10}), lessees must demonstrate that their facilities' projected emissions do not exceed an exemption rate established under BOEM's AQRP. Where an exemption rate is exceeded, the lessee must conduct dispersion analysis to predict onshore impacts of their proposed facility's emissions. Where dispersion analysis indicates that the facilities' emissions would exceed an applicable air quality standard, the lessee must propose controls to reduce the emissions.

While dispersion analysis is not applicable to emissions of volatile organic compounds (VOCs), the AQRP requires lessees to demonstrate that their proposed facilities' emissions of VOCs do not exceed the exemption threshold established by BOEM at 30 CFR 550.303(d). Or, where the facilities' emissions of VOC exceed the exemption rate, the lessee must propose controls to reduce the emissions of VOCs.

The emission exemption thresholds established under the BOEM AQRP are given in the following **Equations (1)** and **(2)** for $\boldsymbol{E_n}$:

$$E_{CO} = 3400 \times D^{2/3} \qquad \text{Eq (1)}$$

$$E_{TSP,VOC,SO_2 NO_x} = 33.3 \times D \qquad \text{Eq (2)}$$

Where, E_n is the emissions exemption threshold for the pollutant(s), n; D is the distance from the proposed stationary source to the nearest onshore area; and TSP is Total Suspended Particles, which represents all particle emissions of PM_{10}, and includes $PM_{2.5}$.

Where a lessee is required to propose controls, BOEM must determine that the proposed controls qualify as Best Available Control Technology (BACT) prior to BOEM approving the plan. BACT is defined at 30 CFR 550.302. Each individual EP or DPP proposed by a lessee receives a plan-specific review for compliance with, among other requirements, BOEM's AQRP. Plans that do not meet the requirements of BOEM's AQRP, and the applicable standards therein, will not be approved. In the meantime, this SEIS provides NEPA analysis of a hypothetical Scenario at the lease sale stage - an inherently broader inquiry than the plan-by-plan review conducted under the AQRP. This analysis does not evaluate Scenario activities against specific AQRP standards, such as the exemption threshold noted above. Rather, potential effects are compared to EPA-promulgated thresholds and standards designed to protect public health as well as public welfare, decreased visibility, and damage to animals, crops, vegetation, and buildings. Once lessees submit their plans, should emissions exceed these thresholds, BOEM would likely impose mitigation that would reduce the impact of the emissions.

EPA Clean Air Act Standards. Meanwhile, the CAA provides EPA the authority and jurisdiction to regulate emissions from stationary sources located in state waters (offshore within three miles of shore) and onshore. The EPA has delegated its CAA authority to regulate onshore emissions to the State of Alaska.

The EPA is required to review the NAAQS every five years and update the science, and the standards, if necessary, for the benefit of human health and protection of the environment. Several relevant changes to the NAAQS have become effective since 2008:

- Ozone 8-hour standard was lowered to 0.075 micrograms per cubic meter ($\mu g/m^3$) (73 *FR* 16436, March 27, 2008)
- Lead standard was lowered to a 3-month rolling average of 0.15 $\mu g/m^3$ (73 *FR* 66964, November 12, 2008)
- Sulfur dioxide 1-hour standard was lowered to 75 parts per billion (75 *FR* 35520, June 22, 2010)
- One-hour average standard for nitrogen dioxide (NO_2) was established at 100 parts per billion (188 $\mu g/m^3$) (75 *FR* 6473, February 9, 2010)
- Annual standard for $PM_{2.5}$ was lowered to 12.0 $\mu g/m^3$ (78 *FR* 3086, January 15, 2013)
- A new one-hour average SO_2 standard was established at 75 parts per billion (196 $\mu g/m^3$) on June 22, 2010. See Federal Register 35520.

International Convention for the Prevention of Pollution from Ships. Exhaust from the larger marine engines of ocean-going vessels is controlled by agreements under the MARPOL 73/78 Annex VI International Convention for the Prevention of Pollution from Ships (40 CFR 1043.60(b)). MARPOL is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. Annex VI emission standards for marine engines apply to propulsion engines and auxiliary power generators, as implemented by the U.S. Act to Prevent Pollution from Ships (APPS) (33 USC §§ 1905-1915) and enforced by the U.S. Coast Guard (USCG) (EPA and USCG, 2011). Vehicles (foreign or domestic) operating in the contiguous zone and ocean (seaward of the outer limit of the territorial seas) are subject to MARPOL 73/78), implemented pursuant to 33 CFR Part 151). This analysis assumes application of the MARPOL Annex VI emission factors for NO_x to the propulsion and auxiliary engines for ocean-going vessels.

Evaporative Emissions

Evaporation is the process through which a liquid or a solid substance changes into a vapor, and is released into the air. A substance can evaporate by changing into a vapor at the surface, such as when water evaporates from an uncovered dish. A solid can evaporate into a vapor by melting into a liquid, which then evaporates; or by changing directly into a vapor, through sublimation. The rate of evaporation of a substance depends on its composition, the surface temperature, the vapor pressure of the substance, and the atmospheric humidity.

Under the Scenario, oil spilled into the water is anticipated, which will release hydrocarbons (HCs) evaporated from the spilled oil. There are many varieties of HCs found in oil and some are quickly and easily evaporated into the atmosphere. These are referred to as VOCs. During chemical cleanup of spills, other compounds such as polycyclic aromatic hydrocarbons (PAHs), dioxins furans, heavy metals, and hydrochloric acid may be discharged, but not all will be easily evaporated or may not be evaporated at all (Ramadan, Sleva, Dutner, et al. 1993).

The Scenario also includes releases of natural gas emissions, as well as fugitive releases occurring from leakage, but these small releases are not expected to affect overall quality of the air. Releases from gas systems occur from wellhead to distribution, as natural gas moves through hundreds of valves, processing mechanisms, compressors, and pipelines. When progressing through all these devices, CH_4 can escape to the atmosphere from leaks (EPA, 1999).

Evaporation of Hydrocarbons

HCs are any of the many organic chemical compounds consisting entirely of atoms of both carbon and hydrogen, and some have a tendency to evaporate readily into the surrounding air in the event of an oil spill. Lighter oil (e.g. diesel fuel) will evaporate more quickly when compared to heavier oil (e.g. crude oil), which will evaporate more slowly.

Hydrocarbons are the most abundant compounds found in crude oils, 50% to more than 90% by volume, depending on the source region of the oil (ExxonMobil, 2014). The grade and type of crude oil available from the Alaska North Slope is a medium grade crude, with the highest sulfur content (0.96%) of the “sweet” oils, referred to as Alaska North Slope Oil (ANSO)(ExxonMobil, 2014). Several of the common hydrocarbons found in ANSO crude are summarized in Table 4-15 along with the vapor pressure of the liquid.

Table 4-15. Typical Crude Oil Volatile Hydrocarbons

Substance	Vapor Pressure in psi at 25°C	Substance	Vapor Pressure in psi at 25°C
Propane	137.20	Benzene	1.84
n-Butane	35.23	Cyclohexane	1.89
n-Decane	0.03	Ethylbenzene	0.18
n-Eicosane	2.7^{E-6}	Toluene	0.55
n-Hexane	2.93	*o*-Xylene	0.13
n-Octane	0.27	*p*-Xylene	0.17
n-Pentane	9.92		

Note: 25°C equals 77°F. Source: Fingas, 2011.

Volatility of an HC is a measure of how easily and quickly the compound evaporates when exposed to air. The evaporation rate depends partly on the vapor pressure of the compound. The higher the vapor pressure (volatility) of the compound the more likely, and more easily, the compound will vaporize into the air immediately above the evaporation surface. Notice that in Table 4-15, Propane and *n*-Butane have the highest vapor pressures at a given temperature, and are therefore more easily vaporized than, for instance, *n*-Decane; thus Propane and *n*-Butane are more volatile than *n*-Decane. For example, when assuming the same percent by volume, expect the evaporative emissions of Propane and *n*-Butane to be higher than *n*-Decane.

When VOCs evaporate, they move from the surface of the oil into the air immediately above the oil in the form of a vapor. The air immediately above the oil is the “air boundary layer” (ABL) which should be considered very thin, less than one millimeter. The characteristics of the ABL influence the evaporation rate of the oil.

If the ABL is already saturated with the compound in question (e.g. water vapor), the evaporation rate slows down and approaches zero. Therefore, if the ABL is not already saturated by vapor molecules of VOCs found in the spilled oil, the volume of VOC molecules that can be moved from the surface of the oil to the ABL in a vapor state is so high that the volume is very likely greater than can be evaporated from an oil spill (Fingas, 1994).

There is no evidence from pollutant monitoring that the North Slope adjacent to the Chukchi Sea OCS Planning Area experiences concentrations of VOCs sufficient to constrain evaporation of VOCs into the ABL from an oil spill. Thus, the ABL does not constrain the rapid and continued evaporation of VOCs from an oil spill over the Chukchi Sea, and a medium weight crude oil, such as ANSO, can quickly lose up to 45% of volume from a spill. The Gulf of Mexico oil spill in 2010 lost approximately 60% of the volume of the oil spill shortly after the under-water release of oil at high pressure (Fingas, 2012).

Ozone Levels

Ozone (O_3) is a secondary pollutant that is not emitted directly into the atmosphere from a source (i.e. not a primary pollutant). Rather, O_3 forms due to a complex series of photochemical reactions that require the presence of precursor pollutants, such as VOCs, and nitrogen dioxide (NO_2) and nitric oxide (NO) (collectively referred to here as NO_x). Also required is sunlight, which is why higher ozone values occur during summer afternoons in areas where sunlight is intense (Ahrens, 2013).

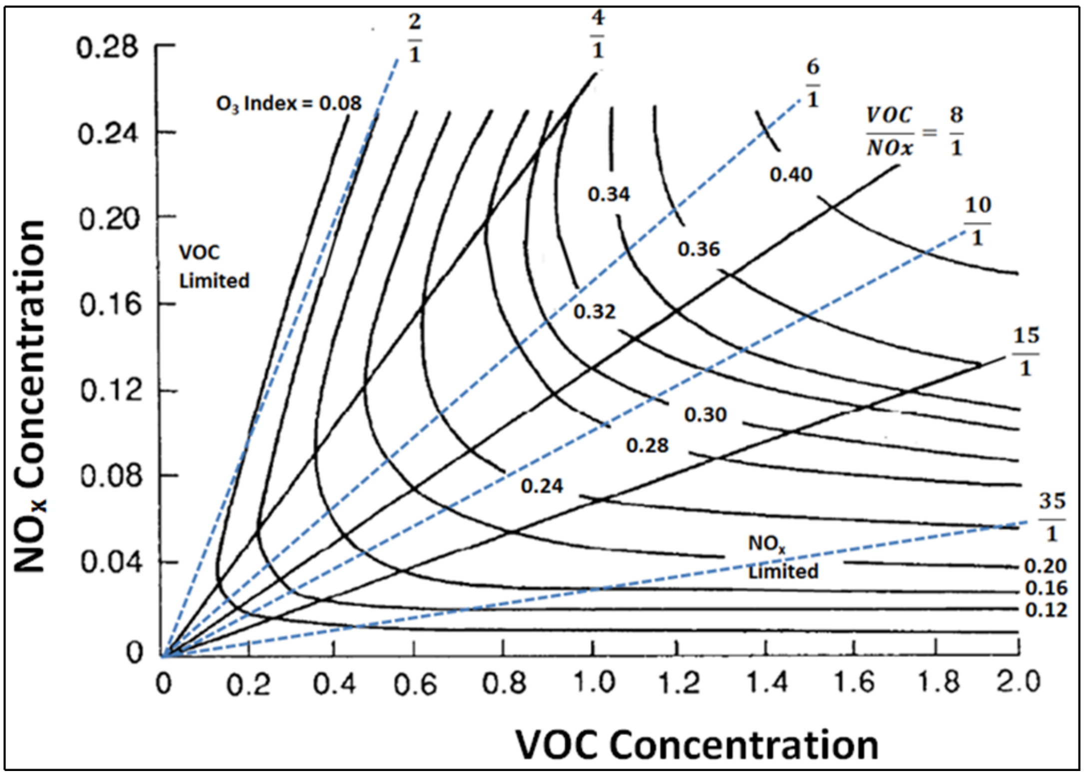


Figure 4-3. Ozone Isopleth Chart.

Note: Emissions of NO_x are assumed to include emissions of both nitrogen dioxide (NO_2) and nitric oxide (NO). Higher emissions of VOC and NO_x result in higher concentrations of the pollutants.

Source: BOEM AOCSR, adapted from Russell and Dennis, 2000; NRC, 1991; Jacobson, 2002; and Finlayson-Pitts and Pitts, 2000.

Generally, surface-based O_3 levels decrease when emissions of both NO_x and VOC are reduced, regardless of the atmospheric conditions. However, the relationship of emission rates of VOC and NO_x to the spontaneous formation of surface-based O_3 is very complex and highly nonlinear. Experiments to examine the peak one-hour concentration of O_3 that forms when mixtures of known initial concentrations of VOC and NO_x are irradiated into a laboratory environmental chamber have been conducted since the 1950s and continued in later years using the Empirical Kinetic Modeling Approach (EKMA) where the results of of the modeling has been tested against the environmental chamber data. The result is the well-documented two-dimensional chart of ozone isopleths shown in Figure 4-3.

As shown on the O_3 isopleth chart above, the highest concentration of O_3 occurs along the axis of the diagram where the mixing ratio of VOC/NO_x is 8:1. The farther the ratio of the pollutants are from the center axis, the less is the concentration of O_3. The primary use of the chart is to discern whether O_3 concentrations may be best controlled by reducing the emissions of VOC, reducing NO_x, or reducing both (Finlayson-Pitts and Pitts, 2000):

- From a point on the 8:1 axis, reduction in emissions of NO_x and VOC, together or separately, results in a steady decrease in the concentration of O_3
- Low ratios: from a point on the 4:1 axis, reducing VOCs results in rapidly decreasing concentrations of O_3; thus, at low mixing ratios, the formation of O_3 is controlled most effectively by reducing emissions of VOC, referred to as "VOC Limited, " just small decreases in VOCs makes a greater impact on O_3 concentration than reducing NO_x emissions by much larger amounts; in fact, decreasing emissions of NO_x in the area of the chart where VOCs are limiting, the concentration of O_3 can actually increase; and
- High ratios: from a point on the 15:1 axis, reducing NO_x emissions results in rapidly decreasing concentrations of O_3; thus, at high ratios, the formation of O_3 is controlled most effectively by reducing emissions of NOx, or is "NO_x Limited," however, it does not appear that reducing VOCs would ever increase the concentration of O_3

It should be understood that surface measurements of VOC and NO_x emissions at a single site cannot be taken as representative of an entire region. In addition, because of pollutant transport throughout any given day, the ratio at one location cannot be expected to be maintained in that location or duplicated downstream. However, "using the concept of the VOC/NO_x mixing ratios to explore qualitatively the implications of various control strategy options is very useful" (Finlayson-Pitts and Pitts, 2000, p.884), and is used in this analysis to predict the likelihood of ozone formation.

Ozone is not the main pollutant impacting the Alaska North Slope, or Alaska in general. The two main pollutants impacting Alaska are CO and particulate matter, specifically $PM_{2.5}$. Nonetheless, the potential for spontaneous formation of ground-level ozone was examined for the exploration, development, and production plans that may be proposed under the Scenario.

Under the Scenario, oil and gas activities reasonably foreseeable for the Chukchi Sea OCS Planning Area will produce emissions of NO_x that far exceed that of VOC emissions, which can be examined in Appendix F. The mixing ratios will be very low, in the range from 0.1:1 to 2:1. Using the O_3 isopleth chart, such a range of mixing ratios indicates that emissions anticipated from the Scenario are "VOC limited."

Without the influx of additional emissions of VOC or a substantial reduction in emissions of NO_x, formation of ozone appears to be unlikely due to the potential emissions under the Scenario. When combined with the unique climate in Alaska, where there is no sunshine during the winter and low-intensity sunlight in the summer, the photochemical reactions necessary to form surface-based ozone are not likely to occur at all.

An accidental oil spill, if large enough, could change the dynamics of the atmosphere if the volume of VOC emissions from the spill produces enough VOC emissions to trigger the formation of ozone. For example, if an oil spill were to release enough VOCs to cause the VOC/NO_x ratio to increase to 3:1 or 4:1, the O_3 standard may be exceeded. However, this would require additional emissions of thousands of tons of VOC.

Impacts of the Scenario through Time

This section provides the analysis of air emissions as they occur through the 77 years of the Scenario. This analysis addresses the particular oil and gas activities that could occur during each relevant time period and analyzes their impacts against the backdrop of a dynamic affected environment. Whereas previous sections have focused on identifying relevant IPFs and the types of environmental impacts they may cause, this section more specifically accounts for the level at which each IPF affects emissions during a given period, the overlap of IPFs, and any additive or synergistic impacts which may result. In total, these sections tell the story of how the activities comprising the Scenario could affect air quality through time.

This analysis takes into account the context and intensity of the impacts defined under Section 4.2 by:

- Identifying emissions sources associated with each activity summarized in Appendix B, Table B-7 for the Scenario (e.g. surveys, exploration plans, production platforms, etc.)
- Quantifying the annual rate of projected emissions from those sources, per the spreadsheets provided in Appendix F, which give details of assumptions and emission factors
- Performing a screening-level dispersion analysis of the greatest predicted potential annual emissions for each period of the Scenario to discern conservative ambient pollutant concentrations resulting from those emissions; and
- Comparing the results of the dispersion analysis to established ambient air quality standards to determine the effect of the emissions according to the Impact Scale found in Section 4.2 of this chapter.

The established ambient air quality standards – promulgated by EPA – are referenced here as quantitative benchmarks or thresholds against which BOEM compares the results of the screening dispersion analysis to assist in discerning potential air quality impacts under NEPA. Specific standards referenced include:

- Significance Levels (SLs)(40 CFR 51.165(b)(2); not to be confused with "significance" as used in the NEPA context); and
- National Ambient Air Quality Standards (NAAQS)(40 CFR Part 50)

Where predicted potential concentrations do not exceed the SLs, emissions from the source are presumed to be *de minimis* and have a negligible effect, per EPA guidance (EPA, 2010a). According to the EPA, the purpose of the SLs is to provide screening thresholds to identify levels of ambient impact that are "sufficiently low relative to the NAAQS or relative to the Maximum Allowable Increments (MAIs) at 40 CFR 52.21(c), such that the impact can be considered *de minimis*" (EPA, 2010a, p. 11). The information in Table 4-16 shows the relationship between the NAAQS and the SLs. Note that the SLs are much lower than the NAAQS - on average 3.2% of the NAAQS. Thus, emissions that result in onshore pollutant concentrations that do not exceed the SLs are such a small fraction of the NAAQS, that the emissions are considered by the EPA to be *de minimis*.

Table 4-16. Comparison of the Air Quality Standards.

Criteria Pollutants	Pollutant Averaging Periods	Ambient Air Standards (μg/m^3)	
		NAAQS 40 CFR Part 50	Significance Levels 40 CFR 51.165(b)(2)
Carbon Monoxide (CO)	1-hr	40,000	2000
	8-hr	10,000	500
Nitrogen Dioxide (NO_2)	1-hr	188	NA
	Annual	100	1
Sulfur Dioxide (SO_2)	1-hr	196	NA
	3-hr	1300	25
	24-hr	Revoked	5
	Annual	Revoked	1
Coarse Particulate Matter (PM_{10})	24-hr	150	5
	Annual	Revoked	1

Criteria Pollutants	Pollutant Averaging Periods	Ambient Air Standards (µg/m[3])	
		NAAQS 40 CFR Part 50	Significance Levels 40 CFR 51.165(b)(2)
Fine Particulate Matter ($PM_{2.5}$)	24-hr	35	1.2
	Annual	12	0.3
Ozone (O_3)	8-hr	0.075 ppb	NA
Lead (Pb)	3-month	0.15	NA

Note: TSP is total suspended particles and was replaced by PM_{10}, which is most accurately defined in modern terms as the collective sum of PM_{10} and $PM_{2.5}$. There are no standards for volatile organic compounds. Ozone is measured in parts per billion (ppb) by volume. Not all pollutants and averaging periods are represented by the Maximum Allowable Increments and the Significance Levels

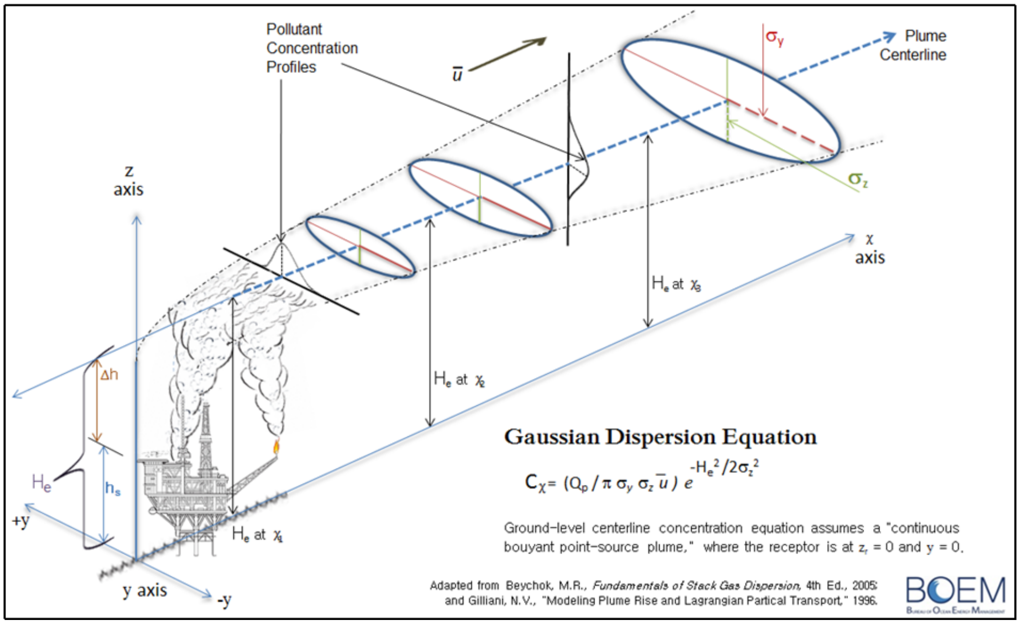
The dispersion analysis performed by BOEM subjects projected potential annual emissions to conditions that influence mechanical dispersion of pollutants in the atmosphere, including the characteristics of the emission sources (mobile and stationary), the location of sources (land, sea, and air), site-specific meteorology (wind speed and atmospheric stability), and the uniqueness of the warming Arctic climate (limited solar radiation).

Dispersion analysis is necessary when impacts from the Scenario cannot be discerned solely from the projected emissions. As previously described, prior to December 2011, the EPA had jurisdiction to control air emission sources on the Chukchi Sea OCS Planning Area, and lessees submitted a permit application to EPA that included results obtained through computer simulation modeling. The modeling included the use of a Gaussian steady-state computer model. Similar modeling would be conducted by lessees to satisfy requirements of BOEM's AQRP in the event that projected potential annual emissions exceeded an applicable AQRP exemption threshold (see above). However, here, at the lease sale stage, such modeling results are not available. Therefore, to discern a measurable impact to human health and the environment, the potential emissions are calculated from a source assumed in the Scenario, and the emissions are translated into potential maximum pollutant concentrations using a screening model, the Gaussian Dispersion Equation mathematical model (Beychok, 2005).

The Gaussian Dispersion Equation predicts the greatest ground-level concentration at a location downwind assuming a continuous buoyant plume, straight-line winds from the direction of the source to the relevant receptor, which is the nearest onshore area, and expresses the solution in micrograms per cubic meter ($\mu g/m^3$). Straight-line winds assume the emissions are constrained within the plume, and are not affected by any other source of mechanical action in any other direction except in the direction of the intended ground-level receptor. The simulation allows the whole of the emission to be transported within the plume from the source to the relevant receptor site allowing the concentration at the plume centerline, which is where the greatest concentration occurs at any given downwind location, to intersect the ground and the relevant onshore receptor. Thus, there would be no other location where the concentration of pollutants would be greater.

The Gaussian Dispersion Equation mathematical model is given in Equation (1) and is visualized in Figure 4-4 along with a legend that explains the variables.

$$C_\chi = \left(Q_p / \pi\, \sigma_y \sigma_z \bar{u} \right) e^{-H_e^2 / 2\sigma_z^2} \qquad \text{Eq (3)}$$



Legend for the "Gaussian Dispersion Equation" Notations

C_χ	=	Maximum pollutant concentration at a point, χ, in micrograms per cubic meter (µg/m³)
Q_p	=	Emission rate of a pollutant, p, in grams per second (g/s)
π	=	Pi, a value of 3.14, where Pi is unitless
e	=	Natural exponential function, unitless, where, $e^1 = 2.718$, $e^0 = 1$, and $\ln x = 1/e^x$
h_s	=	Actual stack height, expressed in meters (m)
Δh	=	Extent of plume rise above the stack at release due to heat bouyancy, where without bouyancy, Δh=0, expressed in m
H_e	=	Effective stack height at a point, χ, where, $h_s + \Delta h = H_e$ at χ=0, and where (H_e at χ_1) > (H_e at χ_2) > (H_e at χ_3),expressed in m
$\bar{u}$	=	Mean surface wind speed in the direction of the χ-axis, averaged over a 10-minute period, recorded at a height 10 meters above the observation surface in miles per hour, and converted to meters per second (m/s)
σ_z	=	Vertical dispersion coefficient after Pasquill (distance of plume's vertical spread below the centerline), expressed in m
σ_y	=	Horizontal dispersion coefficient after Pasquill (distance of plume's horizontal spread outward from the centerline), expressed in m
y	=	Distance from the receptor to the plume centerline in the crosswind, or y-dimension, expressed in m
z_r	=	Distance from the receptor to the plume centerline in the vertical, or z-dimension, expressed in m

Figure 4-4. Gaussian Dispersion Equation. *Diagram and legend of the equation, where the equation assumes Δh is zero and the wind direction is in the direction from the source, in a straight line, to the nearest shore; results in the maximum onshore pollutant concentration. Sources: Gilliani, 1996; Arya, 1999; Beychok, 2005; and Vallero, 2008.*

The greatest pollutant concentration is along the plume centerline when intercepting the surface. This approach should be considered conservative as the assumption of straight-line winds over a distance greater than 50 kilometers (km), which occurs for this analysis, is known to result in an overestimation of pollutant concentrations. Conservative assumptions such as these help to ensure that BOEM is not underestimating air quality effects from the Scenario.

Use of a screening model is appropriate under EPA 40 CFR part 51 Appendix W, Guideline on Air Quality Models, where the EPA recommends that refined modeling should not to be used to the exclusion of other appropriate models, per Appendix W, paragraph 3.0(d). In addition, the Gaussian Dispersion model satisfies the following requirements:

- A screening-level model is appropriate to provide "first tier" conservative estimates (Appendix W, paragraph 2.2(a))

- Meets the requirements for a simple terrain screening model, (Appendix W, paragraph 4.1(b))
- BOEM uses worst-case meteorological conditions, as recommended for a screening analysis, (Appendix W, paragraph 4.2.1.1(b)); and
- The Gaussian Equation model is is the basis for all the procedures of steady-state models preferred by EPA, including AERMOD and SCREEN3, per the AERMOD User's Guide and the SCREEN3 User's Guide, and as described in the Workbook of Atmospheric Dispersion Estimates (Turner, 1970)

Because the dispersion of pollutants is influenced by atmospheric conditions, and atmospheric conditions may change over time due to changing climate, it follows that climate change can influence the dispersion of pollutants, and thus the potential impacts to air quality associated with oil and gas activities comprising the Scenario. The precise manner in which climate change will influence atmospheric conditions in and around the Leased Area cannot be determined with certainty at this time. Therefore, the manner in which climate change will influence air quality impacts associated with the Scenario cannot be precisely predicted. Since climate change is expected to occur equally under all lease sale alternatives, and would influence potential air quality impacts equally under all alternatives, precise knowledge of this issue is not essential for a reasoned choice among alternatives. The projected potential emissions under the five periods of the Scenario includes an accounting of greenhouse gases (GHGs) that contribute to climate change.

Exploration (Years 1-5)

During the first five years, only Exploration will occur under the Scenario. Exploration consists of two main activities – geological and geophysical activities and exploration and delineation well-drilling. While each period has unique operations, they are similar in the characteristics of emissions, primarily from diesel engines.

OCS Marine Seismic Surveys

Vessels conducting the survey follow a path of proposed grid tracks crisscrossing the Chukchi Sea OCS similar to the grid shown in Figure 4-5.

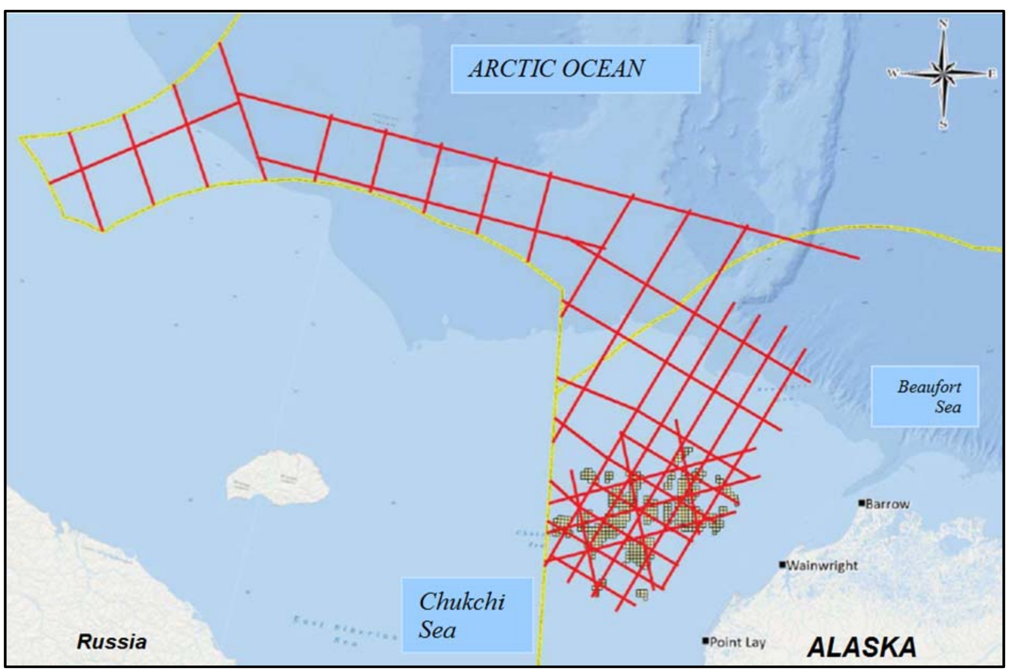


Figure 4-5. Marine Seismic Survey Grid Track. *This image depicts an example of seismic survey grid tracks proposed on the Chukchi Sea OCS. Source: TGS (2013, Figure 1).*

The geological and geophysical exploration for the location of OCS petroleum reservoirs requires marine seismic surveys. Under the Scenario, all seismic surveys conducted on the Chukchi Sea OCS will occur during the open-water season from July through November. Data obtained through seismic research also provides information used to locate geologic hazards, archeological features, biological populations, and for geotechnical engineering purposes. However, geohazard and geotechnical surveys may occur independently of a seismic survey.

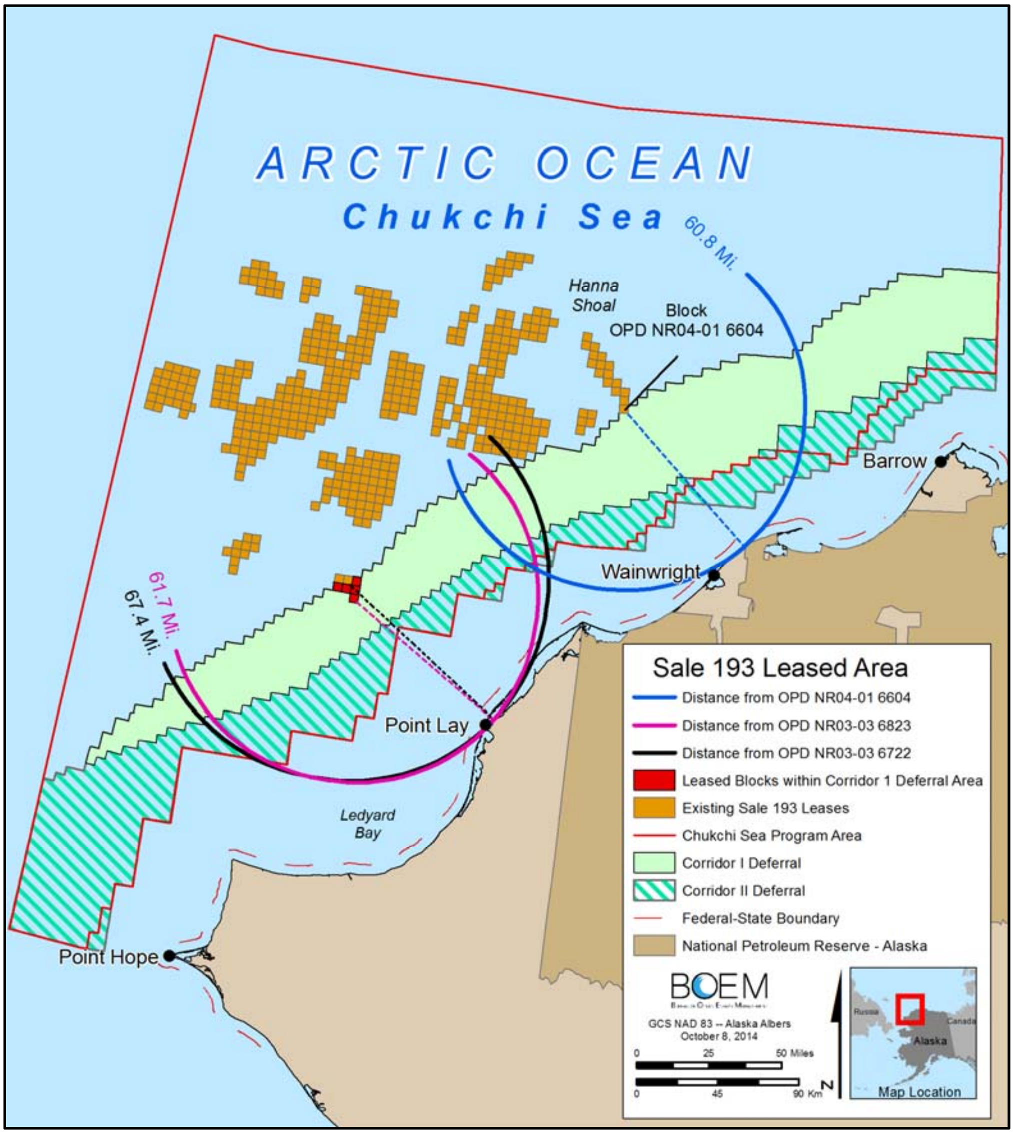


Figure 4-6. Shortest Distance to Shore. *This image depicts arcs that show the shortest distance from shore to the Lease Sale blocks in the Chukchi Sea OCS, both within and outside the Corridor I Deferral area.*

A marine seismic survey would require the use of up to two "source vessels" to pull the seismic source airgun arrays. Two source vessels are used when it is necessary to complete the survey in a shorter period of time. Other ships are required for deploying and receiving seismic detectors (nodes), and several other boats are necessary to support crew housing, complete supply transfers, and conduct research. A monitoring vessel is used to search for marine mammals and scout for ice and other navigation hazards ahead of the seismic vessel(s). Although the geological and geophysical surveys are conducted during the open-water season, this analysis includes the use of an icebreaker vessel.

The ships and smaller vessels must traverse the total length of all the track lines to complete the survey. Far more track lines are proposed than could typically be completed in a single season. This is done to maintain flexibility if some areas cannot be surveyed due to the incursion of sea ice, large numbers of marine mammals in the area, or for other reasons. Source vessels and the vessels deploying and receiving nodes are continually moving throughout the average 90-day period recording seismic profiles along several hundred miles of track. The support vessels are usually moored and anchored near shore until needed, but the actual use of the support vessels would be unique for each survey proposed.

The operations of marine seismic surveys are described in Appendix B, Table B-7, where during the first five years of the Scenario, the operation of one marine seismic survey is reasonably foreseeable. The operation of the survey is short-term and localized.

OCS Geohazard and Geotechnical Surveys

A geohazard or geotechnical survey operated independently of a marine seismic survey would engage support ships similar to those used for a marine seismic survey. However, the main vessel would be a smaller research or monitoring vessel, and an icebreaker vessel would also be required. While it is possible for a geohazard or geotechnical surveys to occur during the same time as a marine seismic survey, geohazard and geotechnical surveys are much smaller in scope and do not cover the larger areas surveyed for a marine seismic survey. The potential emissions projected for the marine seismic survey would be also be valid for geohazard surveys and geotechnical surveys.

The operations of geohazard and geotechnical surveys is described in Appendix B, Table B-7, where during the first five years of the Scenario, the operation of a total of three geohazard surveys and three geotechnical surveys are reasonably foreseeable. The operation of the surveys is short-term and localized.

Exploration and Delineation Well Drilling

The analysis and evaluation of air quality impacts resulting from exploratory and delineation well drilling is based on the use of one drilling unit per rig described in Appendix B, Table B-7. In addition to the drilling unit (rig), an offshore exploration platform requires support vessels, including those appropriate for drilling in the Arctic climate. This includes icebreakers, anchor handlers, science vessels, support tugs, an Arctic oil storage tanker, aircraft, and oil-spill response vessels.

The sources of diesel exhaust from exploration and delineation include engines for drilling, operating the mud-line cellar compressor, cementing and logging units, deck cranes, boilers, draw works, and well-test drilling. In addition to the drilling engines, propulsion and auxiliary engines are used following anchoring for dynamic positioning during which times the engines are considered stationary sources. The emissions would be the same for drilling a vertical well or a delineation well, or a directional well, as most of the difference in the drilling technique happens under the sea surface to establish a slant to the drilling for contact with the well target (Hyne, 2012).

The operations exploration drilling and delineations wells is described in Appendix B, Table B-7, where during the first five years of the Scenario, the operation of up to two rigs per year and a total of six rigs is reasonably foreseeable. The operation of the rigs is short-term and localized.

Base Camps and Terminals

Camps and terminal bases are necessary to support all the oil and gas activities anticipated in the Scenario and are considered permanent infrastructure for the purposes of the air quality analysis. Camps typically operate kitchen, dining, and recreation facilities, as well as housing units. The locations of the bases and terminals may be in Barrow, Alaska, or Wainwright, Alaska, or at another undetermined location. Terminal bases include helicopter hangars and other uses of manufactured buildings, each requiring heaters and boilers. Emissions from the routine operation of camps and terminals anticipated for the Scenario are based on data obtained for the BOEM “Arctic Air Quality

Modeling Study: Emissions Inventory" (USDOI, BOEM, 2014c). BOEM includes in the emissions of the operation of the camps and terminals the use of aircraft used to support offshore operations.

The operation of base camps and terminal bases is described in Appendix B, Table B-7, where during the first five years the Scenario includes both the construction and operation of five permanent facilities: an exploration base, a production base, a supply boat terminal, and a search and rescue base. Once constructed, operation of each base and terminal is long-lasting and localized.

Small Refined Oil Spills

Small refined spills (≤50 barrels, diesel) have the potential to occur during exploration as shown in Tables 4-1 and 4-2, and could result in evaporative emissions. There also exists the possibility of such small spills occurring during refueling in Kotzebue Sound; however, there is a Fuel Transfer Plan in place for such refueling to minimize such spills. The impacts to air quality from these small refined oil spills are directly related to the increased emissions of evaporating VOCs that comprise the oil. The possible impact from increased emissions of VOCs from any oil spill is the formation of ozone. However, the volume of VOC emissions resulting from such small spills, when considering the levels of NO_x emissions likely already emitted from exploration, is not expected to be sufficient to create conditions favorable for the formation of ozone, as estimated by the relationship visualized in Figure 4-3. For these kinds of small spills, the level of evaporative emissions supports a finding of negligible impacts.

Analysis of Emissions and Evaluation of Dispersion

Documentation of the analysis of emissions and dispersion during this period of the Scenario is found in Appendix F. BOEM projected potential emissions based on the schedule of operations listed in Appendix B, Table B-7. During this period of exploration, the unique combination of offshore surveys and exploration and delineation drilling anticipated to occur during Year 5 causes the greatest potential annual emissions during this period of the Scenario. More potential emissions are predicted for Year 5 than for any of the other four years of the period.

During Year 5, the operation of two surveys simultaneously in the Chukchi Sea OCS is reasonably foreseeable. The potential projected emissions calculated for each survey is conservative, as it includes 10 vessels, including two source vessels, an icebreaker, and allows for emissions of onshore equipment should the survey include on-ice operations. Vessels used for the potential survey include those for node equipment deployment and retrieval, crew housing, and crew transport.

The simultaneous operation of two exploration rigs in the Chukchi Sea OCS, along with the two surveys is assumed to occur in this year. The potential projected emissions calculated for both exploration drilling programs includes the use of 12 vessels, including the MODUs, an icebreaker and anchor handler, a science vessel, an Arctic oil storage tanker, and five vessels for oil-spill response (OSR), including a barge. The database provided in Appendix F shows the number of hours that each engine onboard a vessel would operate. Some engines aboard a vessel are anticipated to operate 24 hours each day of the operation (e.g. drilling and power generation engines aboard the MODU), while others operate intermittently (e.g. emergency generators, and the OSR barge). Some support vessels will be servicing the exploration platforms and would, therefore, be in close proximity of the drilling unit; however, the support vessels would not be operating their propulsion engines when anchored near the rig.

The Scenario includes the construction of two permanent facilities, a production base and a supply boat terminal. In addition the ongoing operation of all five camps and terminals indicated for the Scenario is reasonably foreseeable. The greatest potential projected emissions under Year 5 of the Scenario are summarized in Table 4-17.

Table 4-17. Greatest Potential Projected Emissions – Year 5

Category and Number of Potential Scenario Activities		Criteria and Precursor Air Pollutants, and Ammonia Emissions (tons/year)							
		$PM_{2.5}$	PM_{10}	SO_2	NO_x	VOC	CO	Pb	NH_3
Surveys	2	61.4	61.4	18.3	754.5	68.6	229.9	0.2	5.9
Exploration Drilling	2	142.4	142.4	16.5	3259.7	140.9	936.1	0.0	29.0
Construction of Onshore Camps and Terminals	2	50.6	53.2	20.6	782.2	89.0	1,020.0	0.2	6.5
Onshore Camps and Terminals (includes aircraft)	5	7.2	7.2	4.3	104.8	5.9	17.0	0.5	0.9
Totals		**261.5**	**264.1**	**59.6**	**4901.1**	**304.4**	**2,203.0**	**1.1**	**42.2**
Category and Number of Potential Scenario Activities		**Greenhouse Gases Emissions (metric tons/year)**							
		N_2O	CH_4	CO_2	CO_{2e}				
Surveys	2	142.1	9.9	39,890	40,042				
Exploration Drilling	2	774.6	54.0	222,953	223,781				
Construction of Onshore Camps and Terminals	2	2.80	2.20	188,302	189,198				
Operation of Onshore Camps and Terminals (includes aircraft)	5	22.3	1.55	6,352	6,375				
Totals		**941.8**	**67.7**	**457,496**	**459,397**				

Note: Inventory includes emissions from routine operations of three onshore bases operating beginning in Year 1, and the operations of two new bases in Year 5. Source: Appendix F.

The bulk of the regulated criteria pollutant emissions in Table 4-17 are from the propulsion engines from the two survey source vessels, the MODU's power generators, and propulsion engines from the anchor handler and icebreaker. Emissions from these engines are already controlled under MARPOL Annex VI regulations, which were considered in this analysis.

As shown in Table 4-17, the individual pollutant of concern is NO_x, which is conservatively assumed to be comprised entirely of NO_2. As the emissions of this pollutant are the highest of all those analyzed that are regulated under the CAA, NO_x is the controlling pollutant for this air quality analysis and is the focus of the dispersion analysis. The greatest air quality impact of emissions during Year 5 is determined by applying the pollutant with the highest emissions to the Gaussian Dispersion model, where the equation is shown as Equation (3), and is visualized in Figure 4-4. BOEM assumes the average wind speed over the Chukchi Sea OCS is 5.64 meters/sec (see Table 3-4), and a receptor height of 10 meters, as this is the height at which the wind is measured by the meteorological equipment. The atmospheric stability index is categorized as "D," neutral, the least amount of mixing would take place (Beychok, 2005). The distance from the source to the receptor is 60.8 statute miles, which is the shortest distance from any Lease Sale 193 block (OPD NR04-01 6604) to the Alaska coastline (see Figure 4-6). The calculation of the greatest concentration at the relevant receptor assumes the entire mass of 4,901.1 tons of NO_x are emitted at the same time from a single point source. The solution of the equation shows the greatest 1-hour average concentration over the relevant receptor of $4.22 \mu g/m^3$, or an annual average concentration of $0.421 \mu g/m^3$.

Conclusion

As most of the sources of emissions are mobile during this period of the Scenario, dispersion greatly diminishes the potential for pollutants emitted from sources in one area to cause corresponding adverse effects to air quality in a downwind location. While it is not likely that all these categories of activities would occur at exactly the same moment in time and space, BOEM conservatively assumed the activities would occur simultaneously. Actual impacts would, in reality, be lower as the emissions would occur over a five-year period and over a large area of the sea.

The solution of the equation shows the greatest 1-hour average concentration over the relevant receptor of 4.22µg/m^3, and an annual average concentration of 0.421 µg/m^3. These values are well below the NAAQS for the 1-hour average (2.24% of 188 µg/m^3) and annual average (0.42% of 100 µg/m^3) concentrations of NOx. In addition, the annual average value does not exceed the EPA SL of 1.0 µg/m^3 for NO_x. Thus, the emissions are considered, per EPA guidance, to have a *de minimis* effect. The potential annual emissions of Scenario activities summarized in Table 4-17 for Year 5 are categorized as having a negligible effect, per the BOEM Impacts Scale for NEPA analyses in Section 4.2 of this chapter.

The greatest 1-hour average concentration of NO_x at a distance of 20 statute miles from the source is 20.67 µg/m^3, 11.0% of the NAAQS. This value represents the greatest potential concentration that would occur over potential subsistence hunting areas here defined as the area within 40 statute miles from shore. Concentrations of NO_x would only decrease below this value with the increasing distance to the shoreline. Potential impacts to subsistence activities are addressed in Section 4.3.11.

Exploration and Development (Years 6-9)

During the period six to nine years into the Scenario, exploration continues and development begins. The emissions from development are from constructing platforms and installing offshore and onshore pipelines. The emission will occur mostly from construction equipment operating onboard vessels and use of onshore equipment. The construction requires cranes, underwater trenching, and other activities that use heavy diesel equipment. Most of the equipment used for development will be mobile and short-term, and emissions will be characteristically similar to the mobile source emissions described for surveys and exploration.

Offshore Marine Seismic Surveys

The geological and geophysical exploration for the location of offshore petroleum reservoirs continues into this period of the Scenario and operations during each survey would be as described for Years 1-5. The operations of marine seismic surveys are described in Appendix B, Table B-7, where during the Years 6-9 of the Scenario, the operation of one marine seismic survey in the Chukchi Sea OCS is reasonably foreseeable. The operation of the surveys is short-term and localized.

Offshore Geohazard and Geotechnical Surveys

The geohazard and geotechnical exploration needed to support offshore exploration continues into this period of the Scenario and operations during each survey would be as described for the Years 1-5. The operations of geohazard and geotechnical surveys are described in Appendix B, Table B-7, where during the Years 6-9 of the Scenario, the operation of two geohazard surveys and two geotechnical surveys in the Chukchi Sea OCS are reasonably foreseeable. The operation of the surveys is short-term and localized.

Exploration and Delineation Well Drilling

Exploration and delineation well drilling continues into this period of the Scenario, and operations for each rig would be a described for the Years 1-5. The operation of exploration and drilling rigs is described in Appendix B, Table B-7, where during the Years 6-9 of the Scenario, the operation of a total of eight drilling rigs (two per year) in the Chukchi Sea OCS is assumed. The operation of the rigs is short-term and localized.

Construction of Production Platforms

The operation of production platforms is anticipated to occur beginning in Year 10 of the Scenario, meaning the construction of the platform would need to occur no later than Year 9. The analysis and evaluation of air quality impacts resulting from construction of production platforms is based on the analysis completed for the BOEM Arctic Air Quality Study (USDOI, BOEM, 2014c).

In this air quality analysis, BOEM assumes the construction of a gravity-based structure (GBS). These structures are typically constructed offsite at a dry dock or adjacent to a protected harbor. After delivery to the site, the base is towed to a water location where water is pumped into the structure allowing it to sink below the surface. Afterward, the topside structure is positioned above the base using a crane. Compressed air is added to allow the base to rise allowing connection to the topside structure. The combined base and topside structure are then towed to the site where the GBS will operate. Once the GBS is at the site, the platform is carefully positioned and ballast water is added to the base allowing it to slowly sink to the sea bed. Then the ballast water is displaced with denser material such as stone, sand, or concrete to provide the necessary mass needed to secure the base to the seafloor.

The potential emissions during a year of platform construction includes vessels needed for towing the GBS sections to the site, positioning the base, ballasting the base, as well as the use of support vessels (i.e. resupply vessels) and helicopter support (i.e. three weekly round-trips) necessary to complete connection to the topside. Construction emissions occurring at an unknown offsite location during the assembly of the base and topside units is not included in this analysis but are expected to be minimal. Because this GBS would be located in the Arctic, an icebreaker ship is also necessary. The analysis includes the use of ultra low-sulfur diesel fuel.

BOEM assumes a year of construction to complete installation of a production platform in order to be ready for the first production platform in Year 10 according to the Scenario in Appendix B, Table B-7.

Offshore Pipelines

The installation of offshore oil pipelines is anticipated to occur beginning in Year 6 of the Scenario (offshore gas pipelines are not initiated until Year 27).The analysis and evaluation of air quality impacts resulting from laying offshore and constructing onshore oil pipelines is based on the analysis completed for the BOEM Arctic Air Quality Study (USDOI, BOEM , 2014c).

Pipelines link offshore platforms to onshore refineries and storage facilities and connect to other pipelines. Pipelines are constructed using special pipe laying vessels. There are two types of pipe laying vessels: vessels installing flexible pipe that is unwound from giant reels (S lay), and vessels installing ridged pipe that is welded together while at sea. Also required are two types of dredging vessels: one to dig down into the seabed prior to pipe laying, and once pipe laying is complete, the trailing hopper dredge covers the pipeline to protect it from ice floes if the pipeline is located in shallow waters.

Pipe laying vessels also install underwater valves and pumps, which requires using large heavy-lift cranes. Pipe laying vessels can be self-propelled ships equipped with powerful propulsion and auxiliary engines or they may require towing to the site. Emissions calculated for the installation of offshore oil pipelines are valid also for offshore gas pipelines.

BOEM assumes a year of construction to complete installation of a maximum of 40 miles of offshore pipeline, as given in Appendix B, Table B-7. The construction of pipelines is short-term and localized.

Onshore Pipelines

The installation of onshore oil pipelines is anticipated to occur beginning in Year 6 of the Scenario (onshore gas pipelines are not initiated until Year 27). BOEM assumes installing onshore pipeline consists of clearing a path for the above-ground pipeline, setting and securing the braces, pulling the pipe into position, and then securing the pipeline. Machinery and equipment used for this process includes hydraulic excavators, bulldozers, tractors, trenchers, and wheel excavators. BOEM assumes construction would occur over the course of 180 days, during the warmest part of the year. The equipment is expected to operate 15 hours each day over the 180 days to complete installation of a maximum of 75 miles of onshore pipeline, as given in Appendix B, Table B-7. BOEM assumes the construction equipment complies with Tier 1 to Tier 3 emission standards, where emissions depend on the horsepower of the engine, and which are set by the EPA under 40 CFR 89.112. Emissions calculated for the installation of onshore oil pipelines are valid also for onshore gas pipelines.

Small Refined Oil Spills

Small refined spills (≤50 barrels, diesel) have the potential to occur during exploration and development. Impacts would be as described in the previous section for the first five years of exploration. For these kinds of small spills, the level of evaporative emissions would not support a finding more serious than a negligible air quality impact either onshore or offshore.

Analysis of Emissions and Evaluation of Dispersion

Documentation of the analysis of emissions and dispersion during this period of the Scenario is found in Appendix F. BOEM projected potential emissions based on the schedule of operations listed in Appendix B, Table B-7. During this period of exploration and development, the unique combination of offshore surveys, exploration and delineation drilling, platform construction, and the construction of both offshore and onshore oil pipelines anticipated to occur during Year 7 causes the greatest potential annual emissions during this period of the Scenario. More potential emissions are predicted for Year 7 than for any of the other three years of the period.

During Year 7, the Scenario assumes the operation of two surveys. Also assumed is the operation of two exploration rigs, and the ongoing operation of five camps and terminals. During this year of the period, the construction of a platform is considered. The Scenario described in Appendix B, Table B-7 does not specify the year that construction of the production platform would occur. Therefore, to be conservative in the projection of potential emissions, BOEM assumed construction of the platform would occur in this year of greatest emissions (Year 7). The installation of oil pipelines, both onshore and offshore begin during this period, and during Year 7 the Scenario assumes the installation of 40 miles of offshore oil pipeline and 75 miles of onshore pipeline. The potential projected emissions under Year 7 of the Scenario are provided in Table 4-18.

Table 4-18. Greatest Potential Projected Emissions – Year 7

Category and Number of Potential Scenario Activities		Criteria and Precursor Air Pollutants, and Ammonia Emissions (tons/year)							
		$PM_{2.5}$	PM_{10}	SO_2	NO_x	VOC	CO	Pb	NH_3
Surveys	2	61.4	61.4	18.3	754.5	68.6	229.9	0.2	5.9
Exploration Drilling	2	142.4	142.4	16.5	3259.7	140.9	936.1	0.2	29.0
Onshore Bases and Terminals (includes aircraft)	5	126.5	133.0	51.5	1955.5	222.5	2550.0	0.5	0.0
Production Platform Construction	1	10.3	14.0	0.06	537.9	30.5	62.5	0.2	4.48
Offshore Pipeline Installation	40 mi	19.3	26.3	1.0	1705.1	87.0	191.4	0.00 4	14.2
Onshore Pipeline Installation	75 mi	53.4	98.1	1.4	713.1	55.7	398.4	0.1	5.9
Totals		**293.9**	**349.3**	**41.5**	**7,075.0**	**388.6**	**1,835.3**	**1.2**	**60.4**

Category and Number of Potential Scenario Activities		Greenhouse Gases Emissions (metric tons/year)							
		N_2O	CH_4	CO_2	CO_{2e}				
Surveys	2	142.1	9.90	39,890	40,042				
Exploration Drilling	2	774.6	54.0	222953,	223,781				
Onshore Bases and Terminals (includes aircraft)	5	22.31	1.55	6,351	6,375				
Platform Construction	1	2.9	0.4	60,024	60,027				
Offshore Pipeline Installation	40 mi	5.4	0.7	112,413	114,038				
Onshore Pipeline Installation	75 mi	3.5	2.5	164,395	164,401				
Totals		**950.8**	**69.1**	**606,026**	**608,665**				

Source: Appendix F.

The bulk of the regulated criteria pollutant emissions in Table 4-18 are from the propulsion engines powering the two survey source vessels, the MODU's power generators, and propulsion engines from the anchor handler and icebreaker. Emissions from these engines are already controlled under MARPOL Annex VI regulations, which were considered in this analysis.

As shown in Table 4-18, the individual pollutant of concern is NO_x, which is conservatively assumed to be comprised entirely of NO_2. As the emissions of this pollutant are the highest of all those analyzed that are regulated under the CAA, NO_x is the controlling pollutant for this air quality analysis and is the focus of the dispersion analysis. The greatest air quality impact of emissions during Year 7 is determined by applying the pollutant with the highest emissions to the Gaussian Dispersion model, where the equation is shown as Equation (3), and is visualized in Figure 4-4. BOEM assumes the same assumptions for wind speed, receptor height, atmospheric stability, and distance from the shore as described for the analysis under Years 1-5.

The calculation of the greatest concentration at the relevant receptor assumes the entire mass of 7,075.0 tons of NO_x are emitted at the same time from a single point source. The solution of the equation shows the greatest 1-hour average concentration at the relevant receptor is 6.09 $\mu g/m^3$, and an annual average concentration of 0.609 $\mu g/m^3$.

Conclusion

As most of the sources of emissions are mobile during this period of the Scenario, dispersion greatly diminishes the potential for pollutants emitted from sources in one area to cause corresponding adverse effects to air quality in a downwind location. While it is not likely that all these categories of activities would occur at exactly the same moment in time and space, BOEM conservatively assumed the activities would occur simultaneously. Actual impacts would, in reality, be lower as the emissions would occur over a four-year period and over a large area of the sea.

The solution of the equation shows the greatest 1-hour average concentration over the relevant receptor is 6.09 $\mu g/m^3$, and an annual average concentration of 0.609 $\mu g/m^3$. These values are well below the NAAQS for the 1-hour average (3.24% of 188 $\mu g/m^3$) and annual average (00.609% of 100 $\mu g/m^3$) concentrations of NO_x. In addition, the annual average value does not exceed the EPA SL of 1.0 $\mu g/m^3$ for NO_x. Thus, the emissions are considered, per EPA guidance, to have a *de minimis* effect. The potential annual emissions of Scenario activities summarized in Table 4-18 for Year 7 would have a negligible effect, per the BOEM Impacts Scale for NEPA analyses in Section 4.2 of this chapter.

The greatest 1-hour average concentration of NO_x at a distance of 20 statute miles from the source is 29.84 µg/m^3, 15.87% of the NAAQS. This value represents the greatest potential concentration that would impact potential subsistence activities here defined as the area within 40 statute miles from shore. Concentration of NO_x would only decrease below this value with the increasing distance to the shoreline. Potential impacts to subsistence activities are addressed in Section 4.3.11.

Exploration, Development, and Production (Years 10-25)

During the period 10 to 25 years into the Scenario, operations of exploration and development continue, and production begins. The emissions from a production platform will occur mostly from the drilling unit system.

Offshore Marine Seismic Surveys

The geological and geophysical exploration for the location of offshore petroleum reservoirs continues into this period of the Scenario and operations during each survey would be as described for Years 1-5. The operations of marine seismic surveys are described in Appendix B, Table B-7, where during the Years 10-25 of the Scenario, the operation of five marine seismic surveys in the Chukchi Sea OCS is reasonably foreseeable. The operation of the surveys is short-term and localized.

Offshore Geohazard and Geotechnical Surveys

The geohazard and geotechnical exploration needed to support offshore exploration continues into this period of the Scenario and operations during each survey would be as described for the Years 1-5. The operations of geohazard and geotechnical surveys are described in Appendix B, Table B-7, where during the Years 10-25 of the Scenario, the operation of seven geohazard surveys and seven geotechnical surveys in the Chukchi Sea OCS are assumed. The operation of the surveys is short-term and localized.

Exploration and Delineation Well Drilling

Exploration and delineation well drilling continues into this period of the Scenario, and operations for each rig would be a described for the Years 1-5. The operation of exploration and drilling rigs is described in Appendix B, Table B-7, where during the Years 10-25 of the Scenario, the operation of a total of 36 drilling rigs (up to four per year) in the Chukchi Sea OCS is assumed. The operation of the rigs is short-term and localized.

Construction and Operation of Production Platforms

The construction and operation of production platforms is anticipated to occur beginning in Year 10 of this period of the Scenario. BOEM assumes that construction of a production platform would occur in the year previous to operation, as indicated in Table B-7 of Appendix B. The analysis and evaluation of air quality impacts resulting from construction, and operation, of production platforms is based on the analysis completed for the BOEM Arctic Air Quality Study (USDOI, BOEM, 2014c). During the period of Years 10-25, the construction of five new production platforms is anticipated along with the ongoing operation of six production platforms. While the construction of a production platform is short-term and localized, the operation of production platforms in the Chukchi Sea OCS is anticipated to be long-lasting, but localized.

Offshore Pipelines

The installation of offshore oil pipelines is anticipated to continue throughout this period of the Scenario. The analysis and evaluation of air quality impacts resulting from laying oil pipelines is as described in the analysis for Years 6-9 of the Scenario. No onshore pipelines are anticipated for this period of the Scenario. The installation of the pipeline is short-term and localized.

Small Refined Oil Spills

Small refined spills (≤50 barrels, diesel) have the potential to occur during exploration and development. Impacts would be as described in the previous section for the first five years of exploration. For these kinds of small spills, the level of evaporative emissions would not support a finding more serious than a negligible air quality impact either onshore or offshore.

Small Crude and Condensate Spills

Sources of air pollutants during this period of the Scenario may include emissions from accidental releases of crude oil and condensate spills. Diesel fuel oil could be spilled either while being transported or from accidents involving vehicles, vessels, or equipment. Small accidental oil spills (< 1,000 barrels) would cause increases in emissions of VOCs. As oil and diesel are composed mostly of VOCs, the volume of evaporated gases would not exceed the volume of the substance spilled and would likely be less, as oil and diesel contain other compounds. Most of the air emissions would occur within a few hours of the spill and would decrease gradually afterward.

During open-water conditions, spreading of the substance and the action by winds, waves, and currents would disperse VOC emissions beyond the initial spill area. However, such small oil spills are likely to quickly evaporate and the VOCs would disperse. A diesel spill would evaporate faster than a crude oil spill as refined oil evaporates more quickly than crude. Also, air quality impacts from a diesel spill would likely be lower than for other spills as the more refined oils are lighter and contain fewer VOCs. If occurring during periods of broken-ice or melting-ice conditions, where exposure to air might be constrained, the emissions of evaporative VOCs may initially be lower than if the spill occurred in open waters, but eventually the oil would either evaporate or be cleaned up in the same manner as for open-water conditions. Should a spill occur during a period of ice cover, evaporative emissions from oil under the ice would be limited, but would eventually be evaporated after the ice melts.

For these kinds of small spills, the level of evaporative emissions would not support a finding more serious than a negligible effect.

Large Oil Spills

Section 4.1.2.5 and Table 4-3 describe the assumptions concerning large oil spills. Such a spill would result in increased emissions of VOCs over an area larger than from a small spill, and evaporation would continue for a longer period of time until the mass of oil is evaporated or removed from the water surface.

Accidental oil spills may originate from platforms, wells, pipelines, or storage tanks. The analysis of a large oil spill in Appendix A, Sec. A-1.2 assumes that a large spill would originate from a pipeline and/or a platform. Oil spills may comprise a variety of oil or petroleum products ranging from refined oils such as diesel, lube and hydraulic oils to crude and condensate oils. Based on the large oil spill described in Appendix A, Sec. A-1.2.1, this analysis of evaporative emissions presumes that a large spill from a platform could potentially be comprised of either crude oil or diesel fuel, where either would be in the amount of 5,100 barrels (bbl), whereas a large spill from a pipeline would be comprised of crude oil in the amount of 1,700 bbl.

Estimations for the rate of evaporation of a water oil spill are mostly the result of experimentation. Fingas (2012) found through experimentation that evaporation rates for the lighter oils were up to an order of magnitude higher than that of water, and the rate of evaporation of the refined oils were even higher. The results, given in grams per minute (g/min), are summarized in Table 4-19.

Table 4-19. Evaporation Rates of Water, Crude Oil, and Gasoline

Substance	Evaporation Rate (g/min)
Water	0.034
Common Canadian crude oil	0.075
Gasoline (lighter refined oil)	0.340

Note: Wind was not a factor for these results.
Source: Fingas (2012)

Estimating emissions of VOCs from evaporation of HCs contained in an oil spill is complex because the HCs in oil are numerous, varied, and ubiquitous. In addition, the oil contains many elements other than HCs, including impurities that vary from source to source, and can also vary over time. As such, a pound of oil will not evaporate to create a pound of VOCs because of the other compounds and impurities in the oil. Rather, the weight of the evaporated VOCs is likely to be some value less than a pound.

The oil spill contains lighter "fractions" of HCs, similar to gasoline, and heavier fractions similar to tars and wax-like hydrocarbons. ANSO is a medium grade crude oil, and according to the NOAA Office of Response and Restoration:

> "ANS[O] crude blends tend to emulsify quickly, forming a stable emulsion (or mousse). The rate of emulsification, while difficult to model, is known to be accelerated by wind mixing, and is thought to be related to the blend's wax content. …
>
> From 15-20% of this product evaporates in the first 24 hours of a spill, depending on the wind and sea conditions, and very little oil is dispersed into the water column. The weathered oil then starts to form a stable mousse with up to 75% water content (thereby increasing the slick volume four-fold), and it undergoes dramatic changes in its physical characteristics.
>
> The viscosity of the oil-in-water mixture increases rapidly and the color usually turns from a dark brown/black to lighter browns and rust colors. As the water content of the emulsion increases, weathering processes (e.g., dissolution and evaporation) slow down." (NOAA, 2015).

With increased time, the oil degrades to a "sticky mousse" consistency, creating a non-homogenous material with a "crust of slightly more weathered mousse surrounding a less-weathered core" (NOAA, 2015). This weathering causes the evaporation rate to steadily decrease.

Air quality impacts from an oil spill are measured by the volume of VOCs that may be released into the lower atmosphere due to evaporation of the oil, relative to the reaction of these VOCs with other elements in the atmosphere to form ozone.

This analysis of a large oil spill, and the impact to air quality, assumes a spill of either of two types, (1) a spill of up to 6,800 barrels of crude oil, which is the aggregate of the 1,700 bbl crude oil spill from a pipeline plus the 5,100 bbl crude oil from platforms (Type I), and (2) up to 1,700 bbl of crude from pipelines plus an additional 5,100 bbl of diesel fuel from production platforms (Type II). Further, BOEM assumes each barrel of crude oil is comprised of 90% VOCs that could evaporate, whereas diesel fuel is assumed to be 100% VOCs. An oil spill of crude oil is assumed to lose, by evaporation of HCs, up to 40% of its volume before emulsifying to the point where evaporation has all but stopped, whereas a diesel fuel spill would lose 60% of its volume before emulsifying. The results of the analysis and the assumptions upon which the analysis is based are given in Table 4-20.

Table 4-20. Evaporation of Hydrocarbons

Total Barrels	Type	Percent HC[1]	Barrels Available for Evaporation[2]	Percent Evaporated[3]	Gallons Evaporated[4]	VOCs Released[5] (short tons)
6,800	Crude	90%	6,120	40%	102,816	375.01
1,700	Crude	90%	1,530	40%	25, 704	93.75
5,100	Diesel	100%	5,100	60%	127,449	475.63
			6,630		153,153[6]	569.38

Notes: HC is hydrocarbons. VOC is volatile organic compounds. One short ton is equivalent to 2,000 pounds (avoir). Each barrel of crude/diesel is equivalent to 42 U.S. gallons. Assumes only a percentage of a barrel of crude spilled is comprised entirely of hydrocarbons, which can be evaporated as VOCs; assumes a pound of crude/diesel, comprised entirely of hydrocarbons, is equivalent to a pound of hydrocarbons released into the lower atmosphere as VOCs; assumes crude API gravity of 32.6 and density of crude is 874.1 kg/m^3 for Alaska North Slope Oil (ANSO); assumes density of diesel fuel is 55.83 lb/ft^3.

[1]Percent HC is what percent of a barrel of crude/diesel is comprised of hydrocarbons.

[2]Only the percent of the volume of crude/diesel that is comprised of HC can be available for evaporation.

[3]Not all the barrels of crude/diesel can actually evaporate during a spill because of time, weathering, thickness, and viscosity. The Percent Evaporated is the portion of the Barrels Available for Evaporation that is expected to readily evaporate; for example, in the case of a Type I spill, 40% of 6,120 bbl is assumed to evaporate and is equivalent to 102,816 U.S. gallons.

[4]The number of U.S. gallons (converted from barrels) of crude/diesel that can be reasonably assumed to readily evaporate as VOCs into the lower atmosphere from the spill.

[5]Assuming all the HC available for evaporation is evaporated as VOCs.

[6]Gallons of fuel evaporated for the Type II oil spill is greater than for Type I because Type II includes refined diesel fuel, which is lighter and more easily evaporated. Thus, there are more barrels of fuel available for evaporation and a higher percentage of the fuel is evaporated.

A large oil spill on the Chukchi Sea OCS, if released from a platform within the area where oil and gas activities are anticipated under the Scenario, would occur at least 60 statute miles from shore. Or, the release could be from a pipeline, which could be released anywhere between shore and a platform. Assuming no oil would freeze into the sea ice, the distance, combined with the wind conditions over the Chukchi Sea, would likely disperse the VOCs and the gases may be picked up by upper-level winds and transported away from the Arctic. However, this would depend on how far and how fast the oil slick spreads. Assuming a large oil spill occurs within the Chukchi Sea OCS, the greatest amount of VOCs that could potentially evaporate from the kind of large oil spill described in Appendix A would be 569.4 short tons, as given in Table 4-20. If the oil were released very near the shoreline, the emissions would become a concern, mostly because the emissions of VOCs could combine with emissions of NO_x already existing in the lower atmosphere or the ABL, to form ozone. The ability of emissions of VOCs to participate in the formation of ozone would depend on whether the large oil spill occurred in the summer or the winter.

Summer Spills

During summer months, the Arctic experiences more frequent precipitation. Summer Arctic weather is driven by two semi-permanent pressure systems, the Icelandic low over Greenland and the Pacific high positioned in the Gulf of Alaska (Ahrens, 2013). The interaction of these two systems results in northwest winds over the Arctic in summer. Breezes can be moderate, up to 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 the dispersion of pollutants. Gaseous pollutants rise with the surrounding air and are caught up in higher steering winds that allow maximum diffusion of pollutants. The most likely summertime impacts from a large oil spill would occur if northwest winds drive pollutants over Alaska's northern coastline and move over the tundra of the North Slope. Impacts would be less likely to occur when northwest winds would direct pollutants parallel to the coastline on the west side of the North Slope or transport pollutants out to sea.

The higher precipitation amounts in the summer tend to remove some pollutants from the atmosphere and unstable rising allows unrestricted mixing of pollutants with cleaner surrounding air. This results in lower pollutant concentrations that have less of an impact on air quality conditions.

The impact of emissions of VOCs, whether from evaporation from an oil spill or some other source, is measured relative to the likelihood that the VOCs will combine with NOx, the other precursor pollutant, to form ozone. However, along with a favorable mixing ratio of VOCs to NOx, the formation of ozone requires sunlight. Given the periods of summer when storms are not occurring and the sun is up, the intensity of sunshine over the Chukchi Sea is not particularly intense as the angle of the sun above the horizon is low. While the opportunity for ozone formation exists, given the short-term existence of a relatively low amount of VOCs evaporated into the ABL from a large oil spill, the impact to air quality, as determined relative to Section 4.2 Impacts Scale, would likely be negligible to minor both offshore and onshore, and although short-lived, could occur over a large area.

Winter Spills

Weather conditions in the Arctic winter are dominated by the Siberian high pressure system over central Russia, and by the semi-permanent Aleutian low, which occurs over the Bering Sea (Ahrens, 2013). 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 the air, the atmosphere is buoyant, and air 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 and Wilcox, 2007). While the wind does not affect the evaporation rate of VOCs from the spilled oil, the wind does assist in the dispersion of the VOCs once evaporated into the ABL.

There are episodes of much lighter winds during frequent winter temperature inversions and less precipitation when compared with summer. 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. Winter inversions are characterized by relatively low wind speeds that restrict the dispersion of pollutants (Ahrens, 2013). The layer of air within a temperature inversion, particularly shallow layers like those associated with the Siberian high, is compressed close to the surface. Thus, emissions of VOCs from an oil spill in the winter may become trapped below a temperature inversion where the dispersion of the emissions are inhibited. This process would increase the possibility of adverse air quality impacts.

The formation of ozone, which is used as a way to measure the adverse impacts of increased emissions of VOCs, is unlikely to occur in the winter over the Arctic due to the months without sunlight, which is a necessary ingredient for the formation of ozone. However, the occurrences of temperature inversions with light winds that could trap VOCs near the surface could be considered a mechanism that causes an adverse impact due to the odors caused by the VOCs evaporating from a large oil spill. From this perspective, the impact to air quality, as determined relative to Section 4.2 Impacts Scale, would likely be negligible to minor both offshore and onshore, and although short-lived, could occur over a large area.

Spill Response

In-situ burning is one potential technique for cleanup and disposal of spilled oil. Any accidental release of crude oil or diesel could catch fire or could be intentionally ignited during cleanup efforts. Burning would increase emissions in a way similar to that described previously for emissions from fossil-fuel combustion. For small spills, because of the small volume of oil and the quick methods of cleanup that are available, the level of effect to air quality likely would be negligible.

In-situ burning as part of a cleanup of spilled crude oil or diesel fuel would increase emissions of NO_x, SO_2, and CO, but would decrease emissions of VOCs as compared to evaporation. Fingas et al. (1995) describes the results of a monitoring program of an oil-spill test burn at sea. The program involved extensive ambient measurements recorded during two burns in which approximately 300 barrels of crude oil were ignited. During the burn, NO_x, SO_2, and CO concentrations were measured only at background levels and frequently were below detection limits. Ambient levels of VOCs were high within about 100 meters of the fire but were lower than those associated with a non-burning spill.

Another principle contributor of pollution from an oil fire or in-situ burning would be soot, or Black Carbon. This soot may be deposited on ice or snow and cause increased melting because the dark particles absorb heat (the albedo effect). A layer of soot, locally referred to as “Arctic Haze,” moves over the Chukchi Sea OCS from western sources in Russia and China late in the fall of each year, and dissipates in the spring. This phenomena may influence the albedo effect and cause additional warming in the Arctic.

Smoke from burning crude oil would contain PAHs. Benzo(a)pyrene, which is often used as an indicator of the presence of carcinogenic varieties of PAHs, and is present in crude-oil smoke in very small amounts, but in quantities approximately three times larger than in the unburned oil (Evans et al., 1988).

Cleanup of a large oil spill would likely result in detectable impacts to air quality conditions when considering the emissions from the oil, either evaporative or from burning, combined with all the emissions from vessels, equipment, and personnel needed to remove the oils. Thus, the methods and consequences of the process and methods used to remove oil from a large spill may actually outweigh the air effects of the oil itself. From this perspective, a large oil spill, as determined relative to Section 4.2 Impacts Scale, would be likely to have a minor effect both offshore and onshore, and although short-lived, could occur over a large area.

Analysis of Emissions and Evaluation of Dispersion

Documentation of the analysis of emissions and dispersion under this period of the Scenario is found in Appendix F. BOEM projected potential emissions based on the schedule of operations listed in Appendix B, Table B-7. During this period of exploration, development, and production, the unique combination of offshore surveys, exploration and delineation drilling, the operation of several production platforms, combined with modest levels of offshore pipeline construction anticipated to occur during Year 23 causes the greatest potential annual emissions during this period of the Scenario. More potential emissions are predicted for Year 23 than for any of the other 15 years of the period.

During Year 23, the Scenario assumes the short-term operation of one marine survey. Also assumed is the operation of three exploration rigs, the ongoing operation of five production platforms, the installation of 20 miles of offshore pipeline, and the ongoing operation of five camps and terminals. During this year, no new activities are considered that are not already considered in the previous periods of the Scenario.

BOEM also conservatively assumes a 6,800 bbl oil spill (representing the aggregate of a 5,700 bbl platform spill and a 1,700 bbl pipeline spill) causing evaporative VOC emissions, and the in-situ burning of that oil during cleanup. The potential projected emissions under Year 23 of the Scenario are provided in Table 4-21.

Table 4-21. Greatest Potential Projected Emissions – Year 23.

Category and Number of Potential Scenario Activities		Criteria and Precursor Air Pollutants, and Ammonia Emissions (tons/year)							
		$PM_{2.5}$	PM_{10}	SO_2	NO_x	VOC	CO	Pb	NH_3
Surveys	1	30.7	30.7	9.1	377.2	34.3	115.0	0.1	2.9
Exploration Drilling	3	213.5	213.5	24.7	4,889.5	211.3	1,404.1	0.3	43.5
Onshore Bases and Terminals (includes aircraft)	5	7.2	7.2	4.3	104.8	5.9	17.0	0.5	0.9
Production Platform Operation	5	774.0	795.0	6,530.0	25,308.5	908.5	8,250.5	0.01	210.9
Offshore Pipeline Installation	20 mi	9.7	13.2	0.5	852.6	43.5	95.7	0.0	7.1
Oil Spill Evaporation	-					569.4			
In-Situ Burning	-	2.1	2.1	22.4	5.4	0.16	0.27	0.0	0.0
Totals	-	1,037.1	1,061.6	6,591.0	31,538.0	1,773.1	9,882.6	0.9	265.3

Category and Number of Potential Scenario Activities		Greenhouse Gases Emissions (metric tons/year)			
		N_2O	CH_4	CO_2	CO_2e
Surveys	1	71.4	4.95	19,9445	20,021
Exploration Drilling	3	1,162.	81.0	334,429	335,672
Onshore Bases and Terminals (includes aircraft)	5	22.3	1.6	6,352	6,375
Production Platform Operation	5	1,936.5	629,943.5	10,212,195.5	10,844,0762
Offshore Pipeline Installation	20 mi	5.4	0.7	112413	114038
In Situ Burning	-	0.07	-	3,161	3,161
Totals	-	3,197	630,033	10,688,495	11,323,344

Source: Appendix F

The bulk of the regulated criteria pollutant emissions in Table 4-21 are from the drilling and pumping engines onboard production platforms and the power generators onboard the MODUs. The engines used onboard the production platforms are stationary non-road diesel engines that may be controlled to reduce emissions should it be demonstrated that onshore pollutant concentrations exceed Federal levels.

As shown in Table 4-21, the individual pollutant of concern is NO_x, which is conservatively assumed to be comprised entirely of NO_2. As the emissions of this pollutant are the highest of all those analyzed that are regulated under the CAA, NO_x is the controlling pollutant for this air quality analysis and is the focus of the dispersion analysis. However, the production platform emissions cause the highest emissions of sulfur oxides yet seen under any of the previous periods of the Scenario. Therefore, the emissions of SO_x are conservatively assumed to be comprised entirely of SO_2, and the SO_x emissions were considered in the dispersion analysis.

The greatest air quality impact of emissions during Year 23 is determined by applying the emissions of NO_2 and SO_2, given in Table 4-21, to the Gaussian Dispersion model, where the equation is shown as Equation (3), and is visualized in Figure 4-4. BOEM assumes the same assumptions for wind speed, receptor height, atmospheric stability, and distance from the shore as described for the analysis under Years 1-5.

The calculation of the greatest concentration at the relevant receptor assumes the entire mass of 31,538.0 tons of NO_x are emitted at the same time from a single point source. The solution of the equation shows the greatest 1-hour average concentration at the relevant receptor is 27.15 μg/m^3, and the annual average concentration of 2.71 μg/m^3.

The calculation of the greatest concentration at the relevant receptor assumes the entire mass of 6,591.0 tons of SO_x are emitted at the same time from a single point source. The greatest 1-hour average concentration at the relevant receptor is 5.67 μg/m^3, with a 24-hour average concentration of 3.40 μg/m^3, and an annual average concentration of 0.567 μg/m^3.

Conclusion

While it is not likely that all these categories of activities would occur at exactly the same moment in time and space, BOEM conservatively assumed the activities would occur simultaneously. Actual impacts would, in reality, be lower as the emissions would occur over a 16-year period and over a large area of the sea.

The solution of the equation, when considering SO_x emissions, shows the greatest 1-hour average concentration at the relevant receptor, is 5.67 μg/m^3. This value is far below the NAAQS for the 1-hour concentration of SO_x (2.88% of 197 μg/m^3). When considering the other averaging periods, the greatest 3-hour average concentration at the relevant receptor is also 5.67 μg/m^3. This and the 24-hour average concentration of 3.40 μg/m^3 are both below the SLs, and are considered, per EPA, to have a *de minimis* effect.

The solution of the equation, when considering NO_x emissions, shows the greatest 1-hour average concentration at the relevant receptor is 27.15 μg/m^3, with an annual average concentration of 2.71 μg/m^3. These values are well below the NAAQS for the 1-hour average (14.44% of 188 μg/m^3) and annual average (2.71% of 100 μg/m^3) concentrations of NO_x. However, the annual average value exceeds the EPA SL of 1.0 μg/m^3 for NO_x. Therefore, the emissions are not considered, per EPA guidance, to have a *de minimis* effect. Per the BOEM Impacts Scale for NEPA analyses in Section 4.2 of this chapter, while the emissions from the production platforms, which are the greatest emitter during this period, are long-lasting the emissions are localized. The potential projected annual emissions of Scenario activities summarized in Table 4-21 for Year 23 will have a minor effect; emissions of the other pollutants would have a negligible effect.

The greatest 1-hour average concentration of NO_x at a distance of 20 statute miles from the source is 133.03 μg/m^3, which is 67.53% of the NAAQS. This value represents the greatest potential concentration that would potentially affect subsistence activities defined here as the area within 40 statute miles from shore. Concentrations of NO_x would only decrease below this value with the increasing distance to the shoreline. Potential impacts to subsistence activities are addressed in Section 4.3.11.

Development and Production (Years 26-50)

During the period 26 to 50 years into the Scenario, operations of exploration are complete. However, the Scenario assumes a few more surveys, pipelines both onshore and offshore, and the operation of eight production platforms.

Offshore Marine Seismic Surveys

For Years 26-50 of the Scenario, the operation of one marine seismic survey in the Chukchi Sea OCS is assumed in Appendix B, Table B-7. Operations would be as described for Years 1-5 and is short-term and localized.

Offshore Geohazard and Geotechnical Surveys

The geohazard and geotechnical exploration needed to support offshore exploration continues into this period of the Scenario. For Years 25-50 of the Scenario, Appendix B, Table B-7 assumes the operation of one geohazard surveys and one geotechnical surveys in the Chukchi Sea OCS.

Operations during each survey would be as described for the Years 1-5 and are short-term and localized.

Construction and Operation of Production Platforms

The construction and operation of production platforms is anticipated to continue during this period of the Scenario. BOEM assumes that construction of a production platform would occur in the year previous to operation, as indicated in Table B-7 of Appendix B. The analysis and evaluation of air quality impacts resulting from construction, and operation, of production platforms is based on the analysis completed for the BOEM Arctic Air Quality Study (USDOI, BOEM, 2014c). During the period of Years 25-50, the construction of two new production platforms is anticipated along with the ongoing operation of eight production platforms. While the construction of a production platform is short-term and localized, the operation of production platforms in the Chukchi Sea OCS is anticipated to be long-lasting, but localized.

Offshore and Onshore Natural Gas Pipelines

During this period of the Scenario, gas production begins in Year 31 requiring the installation of offshore and onshore pipelines.

Emissions from gas development and production would result from the construction of offshore and onshore pipelines.

Other sources of emissions would be evaporative losses of VOCs from leaks in tanks, pumps, compressor seals, and valves. Reductions in VOC emissions could occur from equipping tanks and valves with seals designed to prevent VOC leakage. Flaring gas would be done for safety purposes; but it also would eliminate most of the VOCs, although some emissions of NO_x, CO_2, SO_2, and PM would be released.

Section 4.1.2.5 describes the assumptions concerning gas releases. Natural gas is comprised almost entirely of methane (CH_4). Because CH_4 is not a hydrocarbon that participates in the formation of ozone, the impact from accidental releases of CH_4 from natural gas systems is not the same as for oil spills. Rather, methane is a greenhouse gas that contributes to climate change. For more information regarding climate change and emissions of CH_4, see Section 3.1.9 as well as the tables in this section. Methane is not a pollutant regulated by BOEM, and releases, whether they be accidental or because of leakage, would cause a negligible impact to onshore air quality.

Small Crude and Condensate Spills

Air quality effects from small crude and condensate oil spills are the same during this period of the Scenario as described for Years 10-25.

Large Oil Spills

Air quality effects from a large oil spill would be the same during this period of the Scenario as described is for Years 10-25.

Spill Response

The air quality effects of responding to a large oil spill would be the same during this period of the Scenario as described for Years 10-25.

Analysis of Emissions and Evaluation of Dispersion

Documentation of the analysis of emissions and dispersion during this period of the Scenario is found in Appendix F. BOEM projected potential emissions based on the schedule of operations listed in Appendix B, Table B-7. During this period of development and production, the unique combination of the operation of several production platforms, along with offshore natural gas and oil pipeline construction, and onshore natural gas pipeline construction anticipated to occur during Year 30 causes the greatest potential annual emissions during this period of the Scenario. More potential emissions are predicted for Year 30 than for any of the other 24 years of the period.

During Year 30, the Scenario includes ongoing operation of eight production platforms, installation of 45 miles of offshore pipeline (5 miles of oil pipeline, 40 miles of natural gas pipeline), the installation of 75 miles of onshore natural gas pipeline, and the ongoing operation of five camps and terminals.

As was analyzed for the previous periods of the Scenario, BOEM conservatively assumes a 6,800 bbl oil spill (the aggregate of a 5,700 bbl platform spill and a 1,700 bbl pipeline spill) causing evaporative VOC emissions, as well as the potential in-situ burning of that oil during cleanup. The potential projected emissions under Year 30 of the Scenario are provided in Table 4-22.

Table 4-22. Greatest Potential Projected Emissions – Year 30.

Category and Number of Potential Scenario Activities		Criteria and Precursor Air Pollutants, and Ammonia Emissions (tons/year)							
		$PM_{2.5}$	PM_{10}	SO_2	NO_x	VOC	CO	Pb	NH_3
Onshore Bases and Terminals (includes aircraft)	5	7.2	7.2	4.3	104.8	5.9	17.0	0.5	0.9
Production Platform Operation	8	1,238.4	1272.0	10,448.0	40,493.6	1,453.6	13,200.8	0.016	337.4
Offshore Pipeline Installation	45 mi	21.7	29.6	1.1	1,918.2	97.9	215.3	0.005	16.0
Onshore Pipeline Installation	75 mi	53.4	98.1	1.4	713.1	55.7	398.4	0.1	5.9
Oil Spill Evaporation						569.4			
In-Situ Burning		2.1	2.1	22.4	5.4	0.2	0.3	0.000	0
Totals		**1,322.8**	**1,409.0**	**10,477.2**	**43,235.1**	**2,182.6**	**13,831.8**	**0.6**	**360.2**

Category and Number of Potential Scenario Activities		Greenhouse Gases Emissions (metric tons/year)			
		N_2O	CH_4	CO_2	CO_2e
Onshore Bases and Terminals (includes aircraft)	5	22.3	1.6	6,352	6,375
Production Platform Operation	8	3,098.4	1,007,912	16,339,512	17,350,522
Offshore Pipeline Installation	45 mi	6.1	0.8	126,465	128,293
Onshore Pipeline Installation	75 mi	3.5	2.5	164,395	164,401
In Situ Burning		0.07	0.0	3,161	3,161
Totals		**3,130**	**1,007,917**	**16,639,884**	**17,652,752**

Source: Appendix F

The bulk of the regulated criteria pollutant emissions in Table 4-22 are from the drilling and pumping engines onboard production platforms. The engines used onboard the production platforms are stationary non-road diesel engines that may be controlled to reduce emissions should it be demonstrated that onshore pollutant concentrations exceed Federal levels.

As shown in Table 4-22, the pollutant of concern is NO_x, which is conservatively assumed to be comprised entirely of NO_2. As the emissions of this pollutant are the highest of all those analyzed that are regulated under the CAA, NO_x is the controlling pollutant for this air quality analysis and is the focus of the dispersion analysis. However, the production platform emissions cause the highest emissions of SO_x, PM, and CO yet seen under any of the previous periods of the Scenario. Therefore, the emissions of SO_x, PM, and CO are included in the dispersion analysis; the emissions of SO_x are conservatively assumed to be comprised entirely of SO_2 for this analysis.

The greatest air quality impact of emissions during Year 30 is determined by applying the emissions of NO_2, and emissions from the pollutants listed above, to the Gaussian Dispersion model, where the equation is shown as Equation (3), and is visualized in Figure 4-4. BOEM assumes the same assumptions for wind speed, receptor height, atmospheric stability, and distance from the shore as described for the analysis under Years 1-5.

The calculation of the greatest concentration at the relevant receptor assumes the entire mass of 43,235.1 tons of NO_x are emitted at the same time from a single point source. The solution of the equation shows the greatest 1-hour average concentration at the relevant receptor is 37.22 $\mu g/m^3$, with an annual average concentration of 3.72 $\mu g/m^3$. The emissions of SO_x, PM, and CO were applied to the dispersion analysis in the same way as the NO_x emissions. Results of the dispersion analysis for the other pollutants are:

- SO_x: Greatest 1-hour average and 3-hour average concentrations at the relevant receptor is 9.02 $\mu g/m^3$, the 24-hour average concentration is of 5.41 $\mu g/m^3$, and the annual average concentration of 0.0.906 $\mu g/m^3$
- CO: Greatest 1-hour average concentration at the relevant receptor is 11.91$\mu g/m^3$, with an 8-hr average concentration of 10.72$\mu g/m^3$
- PM_{10}: Greatest 24-hour average concentration at the relevant receptor is 0.73 $\mu g/m^3$, with an annual average concentration of 0.121 $\mu g/m^3$
- $PM_{2.5}$: Greatest 24-hour concentration at the relevant receptor is 0.68 $\mu g/m^3$, with an annual average concentration of 0.1139 $\mu g/m^3$

Conclusion

While it is not likely that all these categories of activities would occur at exactly the same moment in time and space, BOEM conservatively assumed the activities would occur simultaneously. Actual impacts would, in reality, be lower as the emissions would occur over a 25-year period and over a large area of the sea.

The solution of the equation applied to NO_x emissions shows the greatest 1-hour average concentration at the relevant receptor is 37.22 $\mu g/m^3$, with an annual average concentration of 3.72 $\mu g/m^3$. These values are well below the NAAQS for the 1-hour average (19.80% of 188 $\mu g/m^3$) and annual average (3.72% of 100 $\mu g/m^3$) concentrations of NO_x. However, the annual average value exceeds the EPA SL of 1.0 $\mu g/m^3$ for NO_x. Thus, the emissions are not considered, per EPA guidance, to have a *de minimis* effect. Per the BOEM Impacts Scale for NEPA analyses in Section 4.2 of this chapter, the emissions from the production platforms, the greatest emitter during this period, are long-lasting but localized, and will decrease once the pipeline installations are complete. Therefore, the potential projected annual emissions of Scenario activities summarized in Table 4-22 for Year 30 will have a minor effect; emissions of the other pollutants would have a negligible effect. During the years of this period of the Scenario, emissions are the greatest than in any other period of exploration, development, production, or decommissioning.

The greatest1-hour average concentration of NO_x at a distance of 20 statute miles from the source is 182.37$\mu g/m^3$, which is 92.6% of the NAAQS. This value represents the greatest potential concentration that would affect potential subsistence activities here defined as the area within 40 statute miles from shore. Concentration of NO_x would only decrease below this value with the increasing distance to the shoreline. Impacts to subsistence activities are addressed in Section 4.3.11.

Production (Years 51-74)

Oil and gas activities on the Chukchi Sea OCS during this period of the Scenario continue as described previously, but decline in extent as reservoirs are depleted and taken off-line. The operation of eight production platforms is assumed, at least during the earlier years of this period. The only other activity that would be anticipated during this period of the Scenario are the ongoing operations of five camps and terminals, and operations to decommission subsea wells, which would be anticipated to occur during years 54-65.

This period of the Scenario does not include the operation of any surveys, exploratory or delineation drilling, construction of new production platforms, or new pipeline installations.

Decommissioning Subsea Wells

Decommissioning subsea wells in the Chukchi Sea OCS requires the use of a MODU but does not require all the supporting vessels used during exploratory drilling. The process requires a support vessel and OSR vessels for safety. The process of decommissioning a well is a 15-day process and the MODU may decommission more than one subsea well from a location.

The operations of decommissioning are described in Appendix B, Table B-7, where during the Years 51-74 of the Scenario, the operation of 30 rigs (up to three per year) in the Chukchi Sea OCS is assumed. The operation of the surveys is short-term and localized.

Analysis of Emissions and Evaluation of Dispersion

Documentation of the analysis of emissions and dispersion during this period of the Scenario is found in Appendix F. BOEM projected potential emissions based on the schedule of operations listed in Appendix B, Table B-7. During this period of production and decommissioning, the unique combination of the operation of all eight anticipated production platforms, along with three decommissioning rigs anticipated to operate occur during Year 57 causes the greatest potential annual emissions during this period of the Scenario. More potential emissions are predicted for Year 57 than for any of the other 23 years of the period.

During Year 57, the Scenario includes the ongoing operation of eight production platforms, the operation of three MODUs for decommissioning subsea wells, and the ongoing operation of five camps and terminals.

As was analyzed for the previous periods of the Scenario, BOEM conservatively assumes a 6,800 bbl oil spill (the aggregate of a 5,700 bbl platform spill, which remains possible until Year 74 when oil and gas production ceases, and a 1,700 bbl pipeline spill, which remains possible until Year 53 when oil production ceases) causing evaporative VOC emissions, and the in-situ burning of that oil and/or diesel during cleanup. The potential projected emissions under Year 57 of the Scenario are provided in Table 4-23.

The bulk of the regulated criteria pollutant emissions in Table 4-23 are from the drilling and pumping engines onboard production platforms. The engines used onboard the production platforms are stationary non-road diesel engines that may be controlled to reduce emissions should it be demonstrated that onshore pollutant concentrations exceed Federal levels.

Table 4-23. Greatest Potential Projected Emissions – Year 57.

Category and Number of Potential Scenario Activities		Criteria and Precursor Air Pollutants, and Ammonia Emissions (tons/year)							
		$PM_{2.5}$	PM_{10}	SO_2	NO_x	VOC	CO	Pb	NH_3
Onshore Bases and Terminals (includes aircraft)	5	7.2	7.2	4.3	104.8	5.9	17.0	0.5	0.9
Production Platform Operation	8	1,238.4	1,272.0	10,448.0	40,493.6	1,453.6	13,200.8	0.0	0.0
Decommissioning	3	38.3	38.3	3.8	886.6	39.4	260.5	0.01	7.5
Oil Spill Evaporation						569.4			
In-Situ Burning		2.13	2.13	22.42	5.43	0.161	0.27	0.0	0.0
Totals		**1,286.0**	**1,319.6**	**10,478.5**	**41,490.4**	**2,068.5**	**13,478.5**	**0.6**	**345.8**

Category and Number of Potential Scenario Activities		Greenhouse Gases Emissions (metric tons/year)				
		N_2O	CH_4	CO_2	CO_2e	
Onshore Bases and Terminals (includes aircraft)	5	22.3	1.6	6352	6375	
Production Platform Operation	8	3,098.4	1,007,909.6	16,339,512.8	17350522	
Decommissioning	3	199.3	13.9	57,358	57,571	
In Situ Burning		1.5572	-	3,160.92	3,162.48	
Totals		**3,320.1**	**1,007,928**	**16,406,382**	**17,417,629**	

Source: Appendix F

As shown in Table 4-23, the individual pollutant of concern is NO_x, which is conservatively assumed to be comprised entirely of NO_2. As the emissions of this pollutant are the highest of all those analyzed that are regulated under the CAA, NO_x is the controlling pollutant for this air quality analysis and is the focus of the dispersion analysis. While the production platform emissions cause rather high emissions of SO_x, PM, and CO in Year 57 of the Scenario, the emissions are less than calculated for Year 30 in the previous period, where emissions of all pollutants except NO_x were found to have a *de minimis* effect.

The greatest air quality impact of emissions during Year 57 is determined by applying the emissions of NO_x and the pollutants listed above in Table 4-23, to the Gaussian Dispersion model, where the equation is shown as Equation (3), and is visualized in Figure 4-4. BOEM assumes the same assumptions for wind speed, receptor height, atmospheric stability, and distance from the shore as described for the analysis under Years 1-5.

The calculation of the greatest concentration at the receptor assumes the entire mass of 41,490.4 tons of NO_x are emitted at the same time from a single point source. The solution of the equation shows the greatest 1-hour average concentration at the relevant receptor is 35.71 $\mu g/m^3$, with an annual average concentration of 3.57 $\mu g/m^3$.

Conclusion

While it is not likely that all these categories of activities would occur at exactly the same moment in time and space, BOEM conservatively assumed the activities would occur simultaneously. Actual impacts would, in reality, be lower as the emissions would occur over a 24-year period and over a large area of the sea.

The solution of the equation applied to NO_x emissions shows the greatest 1-hour average concentration at the relevant receptor is 35.71 $\mu g/m^3$, with an annual average concentration of 3.57 $\mu g/m^3$. These values are well below the NAAQS for the 1-hour average (19.00% of 188 $\mu g/m^3$) and the annual average (3.57% of 100 $\mu g/m^3$) concentrations of NO_x. However, the annual average value exceeds the EPA SL of 1.0 $\mu g/m^3$ for NO_x. Thus, the emissions are not considered, per EPA guidance, to have a *de minimis* effect. Per the BOEM Impacts Scale for NEPA analyses in Section 4.2 of this chapter, while the emissions from the production platforms, which are the greatest emitters during this period, are long-lasting the emissions are localized. The emissions during this peruid decrease once the decommissioning operations are complete. Therefore, the potential projected annual emissions of Scenario activities summarized in Table 4-23 for Year 57 will have a minor effect.

The greatest 1-hour average concentration of NO_x at a distance of 20 statute miles from the source is 175.0 $\mu g/m^3$, which is 88.8% of the NAAQS. This value represents the greatest potential concentration would impact potential subsistence activities here defined as the area within 40 statute miles from shore. Concentration of NO_x would only decrease below this value with the increasing distance to the shoreline. Impacts to subsistence activities are analyzed in Section 4.3.11.

The history of NO_x emissions throughout the 77 years of the Scenario are illustrated in Figure 4-7.

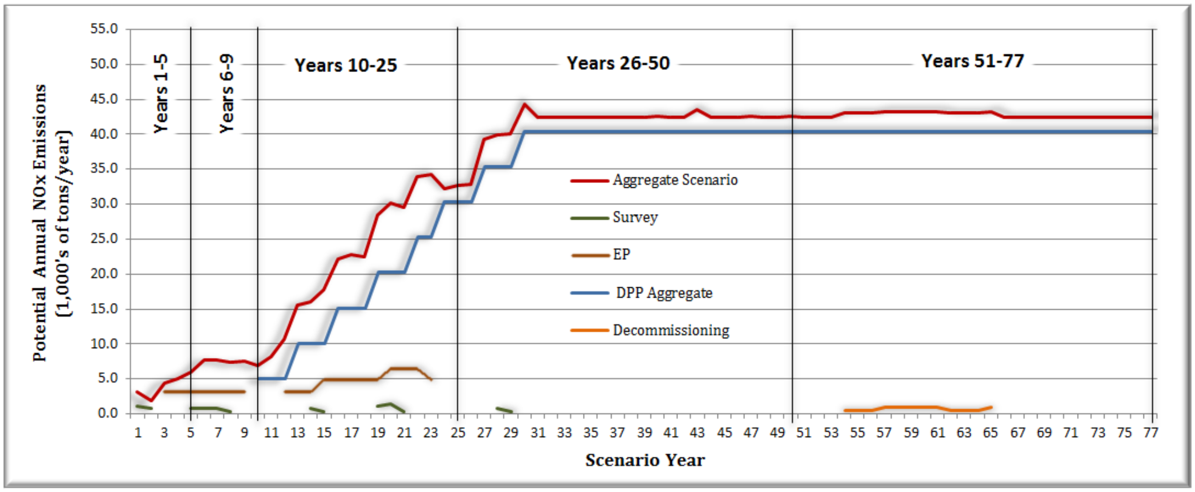


Figure 4-7. Projected NO_x Emissions. *The aggregate of potential NOx emissions throughout the Scenario is illustrated relative to the Scenario activities that contribute the greatest amount of the pollutant to the potential annual projected emissions of NOx.*

4.3.2.2. Alternative II – No Action

Under the "No Action" Alternative, the opportunity to develop oil and gas resources that could have resulted from the Proposed Action would be precluded or postponed until future lease sales, as would any potential air quality impacts associated with the other alternatives. Under this alternative there would be no impacts to air quality from Lease Sale 193.

4.3.2.3. Alternative III – Corridor I Deferral

Alternative III provides the largest deferral area of the action alternatives – a corridor approximately 60 miles (97 km) wide along the Chukchi Sea shoreline. If Alternative III were selected, the distance from the shore to many activities could be greater than under Alternatives I and IV. No exploration or development drilling or platform construction would occur within the corridor, although certain activities (i.e., installation of a pipeline extending from the leases outside the corridor to the shore) could occur there. Of the blocks leased through Lease Sale 193, only five are within Corridor I.

The minimum distance from shore under Alternative III could be slightly greater for the following than under the other action alternatives: length of pipeline from a platform to shore; travel distances from vessels and aircraft; source of emissions, emissions and noise from drilling and platforms; and, potentially the source of a large OCS oil spill.

Under Alternative III, potential air quality impacts onshore could be slightly lower than under the other action alternatives because of the greater distance of many oil and gas activities from shore. Using the Impacts Scale in Section 4.2, the level of impacts under Alternative III would be consistent with the other action alternatives.

4.3.3. Climate Change

As explained in Chapter 3, greenhouse gas (GHG) emissions are one of the causes of climate change. This section discusses the potential effects of the Action Alternatives (Alternatives I, III, and IV) on climate change and how GHG emissions and particulate matter have the potential to influence climate change, particularly in the Arctic. Each of these is considered separately below with respect to the Scenario.

The exploration, development, production, and decommissioning activities under the Scenario would produce GHG emissions, including carbon dioxide, methane and other gases. These GHG emissions would contribute to climate change. Climate change is a global phenomenon, and predicting climate change impacts requires consideration of large scale or even worldwide GHG emissions, not just emissions at a local level. Moreover, the current state of climate science does not enable us to relate specific sources of GHG emissions, such as the Scenario here, to specific climate-related regional or global impacts. What the impact from specific sources would be, if any, depends on emissions from those sources themselves and emissions from other sources throughout the world. In addition, because some GHG gases, such as CO_2, may persist in the atmosphere for up to a century, the potential impacts of any source may extend well beyond the active lifetime of the source or program.

This said, given the greatest potential annual amount of CO_2 emissions from the Scenario, 42.9 million metric tons of CO_2e during Year 57, the amount is relatively low compared to the annual GHGs emitted in the United States during 2013, which was 6,526 million metric tons. As the contribution of the Scenario on an annual basis, is at the greatest point, 0.765%, the potential impact on climate change would likely be small.

Exploration, development, production, and decommissioning activities in the Scenario would also release particulate matter. Fine particles ($PM_{2.5}$) can exist in the atmosphere for several weeks and have local short-term impacts on climate. Light-colored particles reflect and scatter incoming solar radiation, having a mild cooling effect, while dark-colored particles (often referred to as "soot" or "black carbon") absorb radiation and have a warming effect. While the IPCC (2007a) recognizes the potential for "black carbon" (light-absorbing carbon) to deposit on snow and ice, altering the albedo, and enhancing melting, considerable uncertainty exists regarding the net impact of such atmospheric particles on climate. BOEM can reliably conclude, however, that the PM emissions from the Scenario would be small relative to global PM emissions; therefore, the contribution of the PM emissions from the Scenario to global climate change would also be small.

4.3.4. Lower Trophic Organisms

4.3.4.1. Alternatives I and IV

Impact Producing Factors

The activities associated with the implementation of the Scenario would result in five types of IPFs on benthic, pelagic, and epontic lower trophic populations. These IPFs would remain constant for lower trophic organisms throughout all phases of oil and gas activities during the life of the Scenario, only changing in magnitude of impact due to their frequency of occurrence. The following IPFs are further described in Table 4-24, including the duration of their effects on each category of lower trophic organisms.

- ***Habitat Alteration.*** The volume and physical nature of materials displaced by the actions of oil and gas activities (mud, sand, cobblestone, etc.), their dispersal through the water column (density of particles and residence time in the water column), and subsequent deposition on the benthic surface (area and depth of coverage of the benthic surface by displaced materials).
- ***Habitat Alteration.*** The possible introduction of invasive species.
- ***Discharges.*** The net effects of discharges from vessels and platforms.
- ***Noise.*** Noise levels, their source and duration.
- ***Accidental Oil Spills and Gas Releases.*** The effects of accidental oil spills and gas releases (Please see Table 4-24 for a listing of these factors and duration of their effects).

Finally, though not an IPF associated with the Scenario, ocean acidification and climate change would result in changing baseline conditions that would impact benthic, pelagic, and epontic lower trophic populations.

Table 4-24. IPFs and Duration of Effects on Benthic, Pelagic, and Epontic Organisms.

IPFs	Organisms Effected and Duration of Effects		
	Benthic	Pelagic	Epontic
Sediment Displacement and Deposition: Drilling Activities, Scientific and Monitoring Studies, Pipeline Construction	1 or more years, Dependent Upon Depth and Areal Coverage of Deposition	Highly Localized and Temporary	Highly Localized and Temporary
Discharges From Vessels and Platforms	Highly localized and Temporary	Highly Localized and Temporary	Highly Localized and Temporary
Noise Levels From Seismic Activities, Vessels, and Construction Activities	Highly Localized and Temporary	Highly Localized and Temporary	Highly Localized and Temporary
Invasive Species	1 or more years	1 or more years	1 or more years
Small and Accidental Diesel, Crude, Condensate Spills (<1,000 bbl)	No Effects	Highly Localized and Temporary	Highly Localized and Temporary
Large Accidental Diesel, Crude, Condensate Spills (≥1,000 bbl)	1 or more years	1 or more years	1 or more years

Impacts of the Scenario through Time

Exploration (Years 1-5)

The IPFs associated with sediment result from actions that involve disturbance of the benthic surface, and specifically, the volume and physical nature of materials displaced during exploration activities. Construction of mud-lined cellars, and the deployment and retrieving of anchors and chains for mooring during construction of mud-lined cellars and drilling activities would cause displacement and downstream deposition of sediment (Rye and Ditlevesen, 2011). These activities would cause temporary and local increases in turbidity of the water column and loss of benthic communities that are resources to diving marine mammals and pelagic birds through sediment deposition over existing benthic communities (for details of volumes of mud-lined cellars and anchor and chain deposition, please refer to Section 4.3.1 (Water Quality). These areas, depending on substrate types, community composition, and ocean current speeds and directions, would begin the process of recolonization after deposition has completed following benthic disturbance (Conlan and Kvitek, 2005). Period of time for recolonization is dependent upon species, sediment classification (e.g. grain size and percentages of mud, sand, cobblestone, etc.), water current speeds and direction, water temperature, salinity, and areal coverage and depth of sediment plume (Trannum et al., 2010, 2011). Invertebrate species important to large mammalian benthic foragers, such as bivalves, would likely reach sizes readily utilized by foraging mammals at approximately 7-9 or more years depending upon substrate classification, depth, and water temperature (MacDonald et al., 2010). Other benthic foragers such as crabs, fish, and pelagic bird species typically utilize smaller organisms such as amphipods, copepods, shrimp, nematodes, and polychaetes. These are among the first to recolonize taking generally less than a year for establishment in new locations (Trannum et al., 2011).

The sources of discharge from vessels include discharge of cooling water, desalination brine, domestic wastewater, treated sanitary wastewater, runoff from deck surfaces, and drilling fluids. Wastewater would be discharged through a caisson at less than 10 m (33 ft) below the sea surface; at this depth, wastewaters would typically discharge above the temperature-salinity gradient, where it would mix with surface waters. Discharge of water-based drilling muds and drill cuttings in the surface water layer would create a plume of suspended material and increased localized turbidity. The length, width, and depth to which the plume would extend has been modelled using the variables of total water depth, depth of discharge, rate of discharge, and current speed. Discharges are regulated through NPDES general permits for all industry and academic vessels (EPA, 2012a), and are analyzed in Section 4.3.1 that specifically analyzes water quality issues. At these permitted discharge levels, dissipation of warm water, waste waters, and high salinity brine solutions would be temporary and local thus decreasing their effects on planktonic and other lower trophic organisms.

Observations of ocean acidification and understanding of its origin and potential effects have been increasingly noted for U.S. Arctic waters. These changes have been attributed to rising CO_2 levels in the atmosphere and corresponding increases in the CO_2 levels of the waters of the world's oceans, leading to the phenomena of ocean acidification (IPCC, 2007b; Royal Society, 2005). This phenomenon is often called a sister problem to climate change, because they are both attributed to anthropogenic activities that are leading to increased CO_2 levels in the atmosphere. The capacity of the Arctic Ocean to uptake CO_2 is expected to increase in response to climate change (Bates and Mathis, 2009; Fabry et al., 2009). Further, ocean acidification in high latitude seas is happening at a more advanced rate than other areas of the ocean. This is accredited to the loss of sea ice that increases the surface area of the Arctic seas. The exposure of cooler surface water lowers the solubility of calcium carbonate, which results in lower saturation levels within the water, in turn leading to lower available levels of the minerals needed by shell-producing organisms such as pteropods, foraminifers, sea urchins, and mollusks (Fabry et al., 2009). Lower trophic organisms such as these are the base of the food web that supports the fisheries of the Arctic region. Mathis et al. (2014) note the potential effects of strong regional and global changes caused by rapid transitions being brought about due to effects of ocean acidification. Approximately 17% of the Alaska population relies on fishing for subsistence, with far-reaching implications in the cultural importance of fishing as well as its caloric and economic input.

Seismic and side-scan sonar surveys for the purpose of geohazard, geotechnical, and marine seismic surveys, are projected to happen at a maximum rate of one to two a year during the first 29 years of this Scenario. There is no direct scientific evidence that ensonification due to this energy added to the already present background noise of the ocean has effects on lower trophic organisms (Moriyasu, 2004). However, some studies suggest there may be effects. These studies indicate alterations in behavior during larval development are leading to potential problems in recruitment of some invertebrate larvae. Those animals that live within plankton blooms during early developmental stages of their life cycles (meroplankton, such as larval polychaetes, crustaceans, and mollusks) reportedly can perceive energy from ensonification as a component of their perception of the environments they choose to settle for later developmental and adult lives (Lillis, Eggleston, and Bohnenstiehl, 2013). Fish larvae, or icthyoplankton, may be influenced by sound sources at distances of several km in their pursuit of settlement (Montgomery et al., 2006). Ensonification of the water column has been implicated in stranding of Giant squids off the coast of Spain (Andre et al., 2011). Exposure to low-frequency sounds from seismic operations concurrent with strandings of the squid are thought to have resulted in permanent and substantial alterations of the sensory hair cells of the statocysts, the structures responsible for the animals' sense of balance and position.

Introduction of exotic species has been shown to occur in the waters of the Chukchi Sea. Data from the expedition of the RUSALCA program conducted in 2004 showed unexpectedly high numbers of non-native bivalve species in the southeastern Chukchi Sea on a transect from the Russian Siberian Peninsula toward Point Lay on the Chukchi Sea coast (Sirenko and Gageav, 2007). Extensive areas of the bottom northwest of the Bering Strait were dominated by the bivalve *Macoma calcarea*. This species is not endemic to these waters. These populations were thought to be introduced by advection into the Chukchi Sea by Sea of Japan warm water currents that force water and the organisms that are carried with it across the Bering shelf and through the Bering Strait. This serves as an example of the capacity of warm water mid-latitude species to adapt to colder waters of northern latitudes. Anthropogenic introduction of non-native species are a result of movement of equipment and supplies from one area to another during exploration, development, production, and decommissioning. The air gun streamers and all associated equipment in seismic operations, gliders and buoys that operate during all scientific monitoring, and potential bilge water releases of vessels passing through OCS waters would create potential for release of developmental stages of organisms that may survive in Arctic waters with the changes in climate and ice cover in recent years and future projections (Barber et al., 2009, Darnis et al., 2012).

Accidental oil spills during the exploration period are limited to <1,000 bbl of refined hydrocarbon products such as diesel fuel as shown in Tables 4-1 and 4-2. Effects of a spill of this magnitude would be dependent upon sea conditions at the time of the spill. There is a positive relationship between surface disturbance and evaporation rate of refined oil, with greater disturbance leading to higher rates of dissipation and evaporation of refined hydrocarbon products at the ocean surface. With high wind conditions and rough seas, the diesel would be rapidly diluted and dispersed and effects of the spill would be negligible. In calmer waters evaporation of the diesel would be rapid, while area covered by dispersion of remaining hydrocarbons being dependent upon wind speed, wind direction, and water temperature. Loss of benthic organisms due to hydrocarbon poisoning would probably not occur due to dispersion of hydrocarbons before reaching the benthic surface. Smaller oil spills during refueling, such as those proposed at potential place of refuge stations in Kotzebue Sound, would have similar considerations and conclusions. When considering both types of potential spills, impacts on pelagic organisms or lower trophic resources at the surface would be negligible.

Exploration and Development (Years 6-9)

During this phase, exploration and associated IPFs would continue, and development would commence. IPFs during the development phase would remain consistent with those analyzed above, except that increased volumes of IPFs such as sediment displacement, discharges, and anthropogenic noise are increased with commencement of development drilling, platform construction, and offshore pipeline installation. These lead to increases in regional net effects of IPFs. Meanwhile, the effects of climate change and ocean acidification would increase if current trends and predictions are correct (Gosling, 2013, Overland, 2011), and exacerbate the potential of this phenomenon to affect the Arctic Ocean physical and biological environments. Sediment displacement and deposition from exploration drilling activities and pipeline trenching and burial would be the primary IPF in the consideration of movement of materials on the ocean floor during this period.

Accidental oil spills during the exploration and development period are estimated at < 1,000 bbl of refined oil (i.e. diesel fuel). The duration of spill characteristics in the environment would be variable and consistent with those described for small oil spills during the Exploration Phase. Overall the impacts would be negligible.

Exploration, Development, and Production (Years 10-25)

This period features a continuation of exploration and development activities, along with their associated IPFs. Production activities commence during this period, increasing the volume and frequency of IPFs analyzed above. Discharges from vessels and platforms would increase due to the number of vessels and platforms over this period. Individual releases would remain locally and temporarily affecting the environment, with regulations by state and Federal authorities regulating the releases and environmental conditions of weather and sea state reducing their effects on pelagic lower trophic organisms. However, cumulatively the IPFs may lead to greater effects due to the following factors.

During this phase, the drilling of wells and construction of platforms would increase from less than 5 per year to 16 during Year 11 and up to 35 per year throughout Year 25, with up to four MODUs operating at one time. The bulk of pipeline construction would occur during this time period, with supply lines between platforms and the main trunk pipelines between the central platform and shore being trenched and buried during open-water seasons. Other anthropogenic activities such as scientific studies, environmental monitoring, and geological and geophysical surveys, would increase IPFs of habitat alteration in the form of disturbance of the benthic surface, increasing the volume of material dispersed and deposited into the pelagic and benthic environments, and ensonification of the water column.

The release of drill cuttings and drilling muds associated with exploratory and developmental drilling activity, and drilling of service wells during production, would create increased turbidity and increased concentrations of total suspended solids in the water column. Drill cuttings and water-based drilling fluids are comprised of a slurry of particles with a wide range of grain sizes and densities, and various fluid additives may be water soluble, colloidal, or particulate in nature (Neff, 2005). Drill cuttings are particles of sediment and rock extracted from the bore hole as the drill bit penetrates the earth. Water-based drilling fluids consist of water mixed with a weighting agent (usually barium sulfate, $BaSO_4$) and various additives to modify the properties of the mud (Neff, 2005, Neff et al., 2010). Particles that are temporarily suspended in the water column near construction sites of platforms and during drilling activities probably would exceed thresholds set by the EPA (EPA, 2012b). Turbidity above ambient levels caused by increases in suspended particles in the water column would affect water quality in the Leased Area. Turbidity levels are generally expected to remain considerably below 7,500 ppm suspended solids (NRC, 1983). In the immediate vicinity of exploratory drilling and anchor handling activities, turbidity may locally exceed the 7,500 ppm threshold. Local effects on water quality may be high-intensity but would dissipate quickly with distance from the activity, with duration dependent upon water temperature, salinity, and current speed. Effects on water quality resulting from increased turbidity would be local and would generally be restricted to the areas within 100 m (328 ft) of the drilling or anchor handling activity (NRC, 1983; Neff, 2005). Effects resulting from increased turbidity would be temporary and expected to end within a few days after drilling or anchor handling activity stops. Anticipated effects from pipeline construction would have similar results in turbidity from trenching and burying of pipelines during construction.

As a result of the physical and chemical heterogeneity of typical drill cuttings and drilling fluids, the mixture would undergo fractionation (separate into various components) as it is discharged to the ocean. The larger particles, which represent about 90% of the mass of drilling mud solids, would settle rapidly out of solution, whereas the remaining 10% of the mass of the mud solids consists of fine grained particles that would drift with prevailing currents away from the drilling site (Neff, 2005; Neff et al., 2010). The fine-grained particles would disperse into the water column and settle slowly over a large area of the seafloor. Models, lab-scale simulations, and field studies suggest that discharged drilling muds and cuttings would be rapidly diluted to very low concentrations, and that suspended particulate matter concentrations would drop below effluent limitation guidelines within several meters of the discharge (Neff, 2005; Netto, Fonseca, and Gallucci, 2010). In well-mixed waters, particles discharged to the ocean from drilling activities are typically diluted by 100-fold within 10 m (33 ft) of the discharge and by 1,000-fold after a transport time of about 10 minutes at a distance of about 100 m (328 ft) from the platform (Neff, 2005). Material discharged during drilling and construction activities from the seafloor would be similar in composition to naturally-occurring seafloor sediments, and its contribution to turbidity from waves and currents would be about the same as the sediments existing at the seafloor surface before drilling activities (USDOI, BOEM, 2012). Experiments have shown the composition of deposited materials have an effect on recolonization of benthic communities, with natural sediments from disturbance of the benthic surface having less adverse effect on the recolonization rate than drilling muds, and water based drilling muds having less effect than synthetic muds (Trannum et al., 2011).

A previous exploration drilling operation on the Burger prospect is estimated to have disturbed 1,018 ft^2 of seafloor per well, and each well cellar excavated 619 yd^3 of sediment (USDOI, BOEMRE, 2011g). Cuttings from the well cellar excavation were deposited on the seafloor below the temperature and salinity stratification layer. It is estimated that the maximum thickness of the sediment deposition onto the seafloor would be 10.4 ft (3.2 m) and the deposition would continue out to a horizontal distance of 449 ft (137 m) from the excavation site, where it would be 0.4 in (1 cm) thick. The excavation of a mud line cellar in a season would increase sediment, suspended solids, and turbidity in the lower water column above background levels, dependent upon the mineralogy and grain size of the sediments excavated. Currents and severe storm events could re-suspend and transport these newly deposited seafloor sediments (USDOI, BOEMRE, 2011g). After the deposition of materials from the disturbance of benthic surfaces ceases, it could take 4-8 years for the sea floor to return to a state where it is biologically usable for marine mammals, depending on the amount of material and deposition rate.

The ensuing downstream plume from cuttings dispersed into water is normally 10s of meters wide and 100-900 m (328-2,953 ft) long. Disposal of drilling muds and cuttings would be as specified under conditions prescribed by the EPA's NPDES permit. Discharge of drilling muds and cuttings during exploration activities should not cause population-level effects to any marine mammals, either directly through contact or indirectly by affecting prey species. Material discharged during drilling and construction activities from the seafloor would be similar in composition to naturally-occurring seafloor sediments, and its contribution to turbidity from waves and currents would be about the same as the sediments existing at the seafloor surface before drilling activities (USDOI, BOEM, 2012). Experiments have shown the composition of deposited materials have an effect on recolonization of benthic communities, with natural sediments from disturbance of the benthic surface having less adverse effect on the recolonization rate than drilling muds, and water based drilling muds having less effect than synthetic muds (Trannum et al., 2011). Any effects would be localized primarily around the drilling unit because of the rapid dilution/deposition of these materials.

Effects of drilling activities on deposition of metals or chemicals have been tested through monitoring programs using sediment and faunal sampling at sites near former exploratory wells and control collections. BOEM-funded COMIDA-CAB monitoring has investigated the deposition of metals produced by exploratory drilling programs in the early history of exploratory activities in the region of the Leased Area. Fox et al. (2014) tested seawater, sediments, and faunal samples at 58 stations near sites of old exploratory wells. Also sampled were random reference sites within a 56 km (34.8 mi) grid surrounding the drill sites to understand natural environmental background levels. They found no meaningful statistical differences in mercury in water or sediments between the samples collected. Faunal samples tested included amphipods, clams, snow crab (*Chinoecetes opilio*), and Arctic cod. Laboratory results showed minimal evidence of elevated mercury or biomagnification when compared to background mercury levels within this range of organisms. Benthic surface sediments and sediment cores were concurrently collected and tested for anthropogenic input of metals due to drilling activities (Trefry et al., 2014). A suite of 17 metals, including mercury, copper, barium, and lead, were tested for their concentrations in sediments. Analysis found concentrations of metals varied throughout the Leased Area due to natural variation in sediment texture and grain size, but with few exceptions were shown to be consistent with naturally occurring levels. These exceptions were from surveys around two exploratory oil and gas drilling sites that were occupied in 1989 showing that barium concentrations were as high as 10,000 $\mu g\ g^{-1}$ within 200 m of one drilling site relative to background values of ~700 $\mu g\ g^{-1}$. Barium enrichment was from barite, a drilling mud additive that was discharged to the seafloor. Above-background concentrations of copper, mercury, lead, and zinc also were found in sediments from 3–4 stations within 200 m of the same two drilling sites. At the sites tested, sediments in the Leased Area were essentially unaffected with respect to trace metals of anthropogenic origin, excluding small areas nearby drilling sites.

In summary, for routine oil and gas activities, the effects on lower trophic resources resulting from turbidity and deposition of sediments caused by discharged drill cuttings, drilling fluids, pipeline construction and platform construction are expected to be minor because they are short-term and localized. They would be limited to the vicinity of the discharge and would be low-intensity with regard to the lower trophic biota in the Leased Area. These activities would be detrimental to pelagic and benthic organisms, but with a short-term and localized area of effect that would be dependent upon materials, current speed and direction, salinity, and water temperature. While the settlement of suspended sediments would cause turbid conditions, the impacts of deposition on recolonization of benthic fauna would be short-term and localized.

Accidental small and large oil spills during the exploration, development, and production phase are estimated in Tables 4-1, 4-2 and 4-3. The duration of spill characteristics in the environment would be variable and consistent with those described for small oil spills during the Exploration Phase. Small oil spills of ≤50 bbl of crude or condensate are expected to evaporate and dissipate within 3 days, and have a localized effect at the surface or upper pelagic layers. They would have no more than a negligible effect due to the small influence they would exhibit through time and areal coverage to planktonic organisms. Refined oil spills of ≤50 bbl would have similar fates and effects. Chronic spills may potentially occur at approximately 12 spills per year, with an average of ≤3 bbl per spill. These would also have the same level of negligible effects as analyzed with larger spills, with dispersion and evaporation dependent upon sea state and weather patterns creating negligible effects to lower trophic planktonic organisms. Potential large oil spills of 1,700 bbl crude or condensate oil from pipelines or 5,100 bbl of crude, diesel, or condensate oil from platforms would cause effects that are dependent upon timing, sea state, weather patterns, and current speeds. In the event of a large oil spill, the impacts could range from negligible (if hydrocarbons remain at the water surface and be subjected to the effects of sea state and weather patterns allowing for dissipation and evaporation) to minor (if hydrocarbons contact the benthic surface, where there be slower dissipation of oil at depth of benthic surface, and subsequently affect the benthic communities).

The description of effects of contact and impacts should an oil spill contact lower trophic resources have been described in the preceding sections. Following is an explanation of the chance of a large spill contacting the ERAs assuming a large spill occurs. This conditional probability explanation is followed by a discussion factoring in the chance of a large spill occurring and then contacting – called a combined probability.

Conditional Probabilities

Large Spills: Summer. The OSRA model estimates conditional probabilities (expressed as a percent chance) of a large spill contacting important lower trophic habitats identified in Table A.1-16. The following discussion summarizes all LAs and PLs, unless otherwise specified. The OSRA model estimates that the chance of a large spill contacting ERA6 (Hanna Shoal) or ERA 16 (Barrow Canyon), which are important lower trophic habitats (Table A.1-16), ranges from 4-23% from LAs and from 2-36% from PLs within 30 days (Table A.2-27). For 360 days, the range is from 5-25% from LAs and from 4-38% from PLs (Table A.2-30, Maps A-5 and A-2a, 2d). The chance of a large spill contacting ERA 7 (Krill Trap) or ERA 57 (Skull Cliffs) within 30 days from all LAs and PLs ranges from 2-16% and within 360 days ranges from 3-16% (Tables A.2-27 and 30, Maps A-2d, 2e).

All Lower Trophic ERAs have a ≥2% chance of a large spill contacting from any LAs or PL during summer except ERA 75 (Boulder Patch), ERA 80 (Beaufort Outer Shelf 1), and ERA 101 (Beaufort Outer Shelf 2). ERA 75 has a <0.5% chance of contact, and ERA 80 and 101 have a <0.5-2 % chance of contact from all LAs or PLs within 30 or 360 days, respectively.

Large Spill: Winter. The OSRA model estimates conditional probabilities (expressed as a percent chance) of a large spill contacting lower trophic habitats (Table A.1-16). The following discussion summarizes all LAs and PLs, unless otherwise specified. The OSRA model estimates that the chance of a large spill contacting ERA 6 (Hanna Shoal) or ERA 16 (Barrow Canyon) which are important lower trophic habitats (Table A.1-16) ranges from 2-17% from LAs and from 2-25% from PLs within 30 days (Table A.2-51). For 360 days, the range is from 2-20% from LAs and from 3-29% from PLs (Table A.2-52, Maps A-5 and A-1-2a and 2d. The chance of a large spill contacting ERA 7 (Krill Trap) or ERA 57 (Skull Cliffs) within 30 days from all LAs and PLs ranges from <0.5-13% and within 360 days ranges from <0.5-14 (Tables A.2-51 and 54).

All Lower Trophic ERAs have a ≥1% chance of a large spill contacting from any LA or PL during winter within a 30 days except ERA 75 (Boulder Patch) and ERA 101 (Beaufort Outer Shelf 2). ERAs 75, and 101 have a <0.5% chance of contact within 30 days. Within 360 days, all lower trophic ERAs have a ≥1% chance of a large spill contacting from any LA or PL except ERAS 75, 80, and 101. ERA 75 has a <0.5% chance of contact with oil spills at all locations, and ERAs 80 and 101 have <0.5-1% chance of contact at all stations during this time period.

Combined Probabilities

The OSRA model estimates an 11% chance of one or more large spills occurring and contacting important lower trophic habitat (ERAs 6 and 16) within 30 days or 12-13% within 360 days (Table A.2-73). The OSRA model estimates an 3-6% chance of one or more large spills occurring and contacting important lower trophic habitat (ERAs 7 and 57) within 30 days or 3-7% within 360 days (Table A.2-73).

All Lower Trophic ERAs have a ≥3% chance of one or more large spills occurring and contacting except ERAs 75, 80, and 101. The combined probability of one or more large oil spills contacting ERAs 75 and 101 within 30 and 360 days is <0.5%. The combined probability of one or more large spills contacting ERA 80 within 30 and 360 days is <0.5-1%.

Development and Production (Years 26-50)

While exploration activities cease prior to this time period, development and production activities continue, along with their associated IPFs. Noise levels are expected to rise with the increase in platform and underwater construction, but would likely not increase to intensities expected to have impacts on lower trophic organisms.

The potential for invasive species would increase with the number of support vessels, both freshwater and marine, that would be brought to the region from other areas of operation (Menteer and Collins, 2010). The probability of a changing climate coupled with increased opportunities for life stages of organisms to be brought in by anthropogenic vectors would increase likelihood of invasive species. Should establishment of invasive species occur, the impacts would be dependent upon how the species would compete with endemic species in the Chukchi Sea, and how dispersion would affect its geographical range in the new environments.

Accidental small and large oil spills during the development and production phase are estimated in Tables 4-1, 4-2 and 4-3. The duration of spill characteristics in the environment would be variable and consistent with those described for small oil spills during the Exploration Phase or small and large spills in the Exploration, Development, and Production Phase.

Section 4.1.2.5 describes the assumptions for gas release(s). 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 would determine both the amount of methane escaping from the site and the force at which it would be ejected from the sub-benthic surface. In turn, the amount of force combined with percentage of mud, silt, or sand would 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, would 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, would influence the deposition on nearby benthic environments (Birtwell and McAllister, 2002). Deposition of disturbed substrate material onto nearby benthic resources could affect benthic and epibenthic biota through burial or temporary and localized turbidity. However, recovery would occur in less than three generations, and overall impacts would be short-term, localized, and thus considered to be minor.

Production and Decommissioning (Years 51-77)

This period features a further reduction in activities and their associated IPFs. The aforementioned impacts associated with production and monitoring or scientific activities would continue to occur through decommissioning. Climate change is expected to increase effects over the life of the Scenario through rising temperatures, increases in the extent and seasonality of open water, decreased ice cover, increase in water temperature, and increases in ocean acidification. The loss of ice is leading to a much greater effect of absorption of radiative energy and subsequent rise of ocean temperatures in the Arctic region, and the positive feedback loop that is exacerbating the loss of sea ice and increasing effects of ocean acidification (Fabry et al., 2009; Mathis et al. 2014).

Accidental small and large oil spills during the exploration, development, and production phase are estimated in Tables 4-1, 4-2 and 4-3. The duration of spill characteristics in the environment would be variable and consistent with those described for small oil spills during the Exploration Phase, for small and large spills during the Exploration, Development, and Production Phase and gas releases during the Development and Production phase.

Conclusion

The resiliency of the planktonic lower trophic resources is due to their reproductive potential and generational time frames, and the consistent flow of wind and currents pushing new resources into the Chukchi Sea region through advection. The nutrients and lower trophic organisms advected via the waters of the Bering Sea, Gulf of Anadyr, Siberian Sea, and the Alaska Coastal currents would maintain the abundance in populations of the diverse lower trophic organisms throughout the Chukchi Sea. Biological diversity and population abundances, as well as habitation zones of species and abundance of species in those zones would shift with time regardless of human activity. Climate change would likely bring more impact than any other factor other than VLOS spills due to potential effects of warming Arctic waters on the environment, including ocean acidification, changes in habitat, human population growth, shipping and aircraft traffic, and introduction of exotic or invasive species that would survive and thrive due to altered environmental parameters. Because impacts would be long lasting, widespread, and less than severe, a moderate level of impacts is expected over the life of the project. This is due to resiliency for adaptation to the environment and reproductive capacities of lower trophic populations.

4.3.4.2. Alternative II - No Action

Under Alternative II, Lease Sale 193 would not be affirmed and no current leases would be available for further exploratory drilling or other oil and gas development within the Chukchi Sea Planning Area. Exploration activities such as creation of mud lined cellars, anchoring of vessels, and resultant displaced sediment would not continue. Sediment disturbance from development and production activities such as the construction of platforms, anchoring and chain disturbances, and trenching of pipelines would not occur unless additional lease sales were held and leases issued at a later date. Impacts from climate change and the slow rate of change involving invertebrate and plankton species abundance and diversity would continue. Activities such as scientific research and marine vessel and air traffic would continue and likely increase owing to the predicted warming of Arctic waters and subsequent loss of ice cover. The potential of anthropogenic introduction of invasive or exotic species would continue, but at a lower potential of occurrence due to lower oil industry activity levels. Selecting Alternative II would result in a lower level of impact to lower trophic resources, and would reduce impacts to their populations from moderate to negligible.

4.3.4.3. Alternative III – Corridor I Deferral

Alternative III provides the largest deferral area of the action alternatives – a corridor approximately 60 miles (97 km) wide along the Chukchi Sea shoreline. If Alternative III were selected, the distance from the shore to many activities could be greater than under Alternatives I and IV. No exploration or development drilling or platform construction would occur within the corridor, although certain activities (i.e., installation of a pipeline extending from the leases outside the corridor to the shore) could occur there. Of the Lease Sale 193 leases, only five are within Corridor I.

The minimum distance from shore under Alternative III could be slightly greater for the following than under the other action alternatives: length of pipeline from a platform to shore; travel distances from vessels and aircraft; source of discharges, emissions, and noise from drilling and platforms; and, potentially the source of a large OCS oil spill.

The longer distance covered by pipelines and support vessels could increase potential vessel noise and benthic disturbance along the pipeline route. These impacts could be offset by the incremental benefits provided by a somewhat larger area to accommodate the transport of all developmental stages of lower trophic organisms by advection through the Chukchi Sea. During open water, the greater distances between the lease blocks and shore would also lessen the possibility of an accidental oil spill contacting nearshore areas such as the Ledyard Bay Critical Habitat and Skull Cliffs kelp bed resources. During winter, the greater distances between the nearshore leads and OCS development could lessen the risk of impacts from transport of oil spills. Overall, the net benefits to the benthos of decreased benthic disturbance and opportunity of contact with shoreline resources would be incremental. Using the Impacts Scale in Section 4.2, the level of impacts under Alternative III would be consistent with the other action alternatives.

4.3.5. Fish

4.3.5.1. Alternatives I and IV

Impact Producing Factors

This section discusses effects on fish that would occur as a result of exploration, development, and production (to include decommissioning) phases of oil and gas operations in the Chukchi Sea. Under each phase, effects on fish from impact producing factors (IPFs) are analyzed as they relate to that phase.

IPFs which occur in multiple phases are addressed in the phase in which they first appear; these discussions are then referenced where applicable. The 2007 FEIS and 2011 SEIS contain relevant analyses of the IPFs on fish, and those analyses are summarized within the text. Information summarized includes:

- Noise and seismic emissions – 2007 FEIS (Sections IV.C.1.d(1)(a) through IV.C.1.d(2)(b)(6) and Section IV.D.1.d(3)(a)), 2011 SEIS (Section IV.C.4)
- Vessel presence – 2007 FEIS (Sections IV.C.1.d(2)(b)(4)) and 2011 SEIS (Section IV.C.4)
- Wastewater discharges – 2007 FEIS (Section IV.C.1.d(3)(b)) and 2011 SEIS (Section IV.E.5)
- Seafloor disturbance – 2007 FEIS (Section IV.C.1.d(2)(b)(5)) and 2011 SEIS (Section IV.E.5)
- Marine invasive species in light of response actions to a VLOS – 2011 SEIS (Section IV.E.5)

Accidental spills or gas releases, though not considered routine oil and gas activities, could potentially occur during of exploration, development, or production. The types of impacts of small and large spills and gas releases are discussed in the phase in which they first have the potential to occur. The impacts of oil spills or gas releases specific to this Scenario, within the larger context of all other activities that occur during each period of time, are then analyzed in the subsection "Impacts of the Scenario Through Time."

The Chukchi Sea features designated Essential Fish Habitat for Pacific salmon (all life stages for all five species), Arctic cod (late juvenile and adults), saffron cod (late juvenile and adults), and opilio crab (eggs). While this Second SEIS is not intended to provide the basis for EFH consultation, the analysis of potential impacts to the habitats of each of these species are encompassed in the general discussion below.

Throughout this section, fish species are referred to by their common names only. Taxonomic names and life history characteristics of fish species which are widespread and could be impacted by Scenario actions are provided in Table 4-25 for ease of reference while reading this analysis section.

Table 4-25. Common and Taxonomic Names and Habitats of Widespread Fish Species.

Fish Common Name	Taxonomic Name	Dominant Life History Environments
Pacific herring	*Clupea pallasii*	Marine, Nearshore
Capelin	*Mallotus villosus*	Marine, Nearshore
Rainbow smelt	*Osmerus mordax*	Anadromous
Least cisco	*Coregonus sardinella*	Anadromous
Bering cisco	*Coregonus laurettae*	Anadromous
Broad whitefish	*Coregonus nasus*	Anadromous, Freshwater
Humpback whitefish	*Coregonus pidschian*	Anadromous, Freshwater
Arctic char	*Salvelinus alpinus*	Anadromous, Freshwater
Dolly varden	*Salvelinus malma*	Anadromous
Pink salmon	*Oncorhynchus gorbuscha*	Anadromous
Coho salmon	*Oncorhynchus kisutch*	Anadromous
Chinook salmon	*Oncorhynchus tshawytscha*	Anadromous
Chum salmon	*Oncorhynchus keta*	Anadromous
Sockeye salmon	*Oncorhynchus nerka*	Anadromous
Arctic cod/polar cod	*Boreogadus saida*	Marine, Nearshore
Saffron cod	*Eleginus gracilis*	Marine
Ninespine stickleback	*Pungitius pungitius*	Anadromous, Freshwater
White-spotted greenling	*Hexagrammos stelleri*	Marine
Sculpin species*	*Cottidae, Hemitripteridae*	Marine
Arctic alligatorfish	*Aspidophoroides olrikii*	Brackish, Freshwater
Snailfish species*	*Liparis sp.*	Marine
Eelpout species*	*Lycodes sp.*	Marine
Prickleback species*	*Stichaedae*	Marine
Bering wolffish	*Anarhichas orientalis*	Marine
Pacific sand lance	*Ammodytes hexapterus*	Marine, Nearshore
Bering flounder	*Hippoglossoides robustus*	Marine
Starry flounder	*Platichthys stellatus*	Marine, Brackish
Alaska plaice	*Pleuronectes quadrituberculatus*	Marine
Arctic flounder	*Pleuronectes glacialis*	Marine, Brackish
Longhead dab	*Limanda proboscidea*	Marine
Yellowfin sole	*Limanda aspera*	Marine

Notes: These Adult life stage fish could be affected by impact producing factors in marine, nearshore, and freshwater environments in the U.S. Chukchi Sea and coastal waters.

*Sculpin species: Butterfly sculpin, Spatulate sculpin, Arctic staghorn sculpin. Antlered sculpin, Belligerent sculpin, Fourhorn sculpin, Shorthorn sculpin, Great sculpin, Arctic sculpin, Plain sculpin, Hamecon, Crested sculpin, Eyeshade sculpin; Prickleback species: Fourline snakeblenny, Arctic shanny, Stout eelblenny, Slender eelblenny; Eelpout species: Estuarine eelpout, Polar eelpout, Marbled eelpout, Wattled eelpout; Snailfish species: Variegated snailfish, Kelp snailfish, Spotted snailfish.

In the caption, "habitat" equals "Life History Characteristic."

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, 2002; Moulton and George, 2000; Stevenson et al., 2004; Barber, Smith, and Weingartner, 1994,Barber et al., 1997; Craig, 1989; Frost and Lowry. 1983.

Exploration

Activities in the exploration phase are presented in Table 4-26. The type of exploration activities that could cause impacts to fish include: geological and geophysical surveys, exploration drilling, and the presence and transit of vessel traffic. Because exploration activities would affect different depths of the marine environment and different environments (marine, estuarine, freshwater), it follows that different fish species and fish life stages that occur at those depths and in those particular environments may be more affected.

Table 4-26. Type of Exploration Activity and the Environments Affected by the Activity.

Type of Exploration Activity	Environment and Depth[1] Affected – Exploration			
	Marine: Surface Water, Ice	Marine: MidWater Column	Marine: Bottom-water and Sea-floor Sediments	Estuarine and Freshwater all depths
Vessel traffic	x	x		X
Marine seismic surveys (open water, in-ice)	x	x	x	
Controlled source electromagnetic	x	x	x	
Echo sounders	x	x	x	
Side-scan sonar	x	x	x	
Subbottom profilers	x	x	x	
High resolution seismic reflection	x	x	x	
Seafloor core sampling			x	
Icebreaking and ice management	x			
Exploration Drilling:				
Vessel traffic	x	x		X
Anchoring (drillship)		x	x	
Setting, Driving Support Legs (jack-up rig)		x	x	
Seafloor supports (jack-up rig)			x	
Well cellar construction		x	x	
Drilling exploration well	x	x	x	
Vertical seismic profiling	x	x	x	
Accidental fuel spills less than 1,000 barrels	x			X
Cooling water discharge	x	x		
Excess cement discharge	x	x	x	
Desalination brine water discharges	x	x		
Sanitary waste discharge	x	x		
Domestic waste discharge	x	x		
Bilge water (treated onboard)	x	x		
Excavation sediments			x	
Drill cuttings			x	
Cuttings with adhered drilling fluids		x	x	
Water-based drilling fluids		x	x	
Ballast water discharge	x	x		
Blow-out preventer fluid			x	
Vessel discharges	x	x		
Sea-Water Withdrawals	x	x		

Notes: [1]Surface Water and Sea Ice (surface to ~10 m (33 ft) depth); Midwater (~10 m to ~ 3 m (33-9.8 ft) above seafloor); Bottomwater (up to ~3 m (9.8 ft) above seafloor); Seafloor Sediments (to 1 m (3.2 ft) below seafloor).

Noise

Many fish species produce and use sounds for a variety of reasons including aggression, defense, territorial advertisement, courtship, and mating. Some species are able to discriminate between different frequencies and intensities, and can hear and respond to sound signals in their soundscape at distances well beyond the range of vision (Popper et al., 2003).

Fish species differ in responses to sound sources for several reasons including type of sensing organ (e.g. otolith-ear, swim bladder, lateral line), presence or absence of swim bladder, presence or absence of lateral line, ability and speed to swim away, allegiance to territory or dwelling site, life stage (adult, larvae, egg), type of sound source, exposure time to sound source, distance from sound source, and depth of water. The great diversity of adult fish and their responses to sound can be generally divided into three categories: 1) fish without swim bladders that respond only to particle motion (e.g. flounder species); 2) fish with swim bladders not connected to the otilith-ear that respond primarily to particle motion (e.g. salmon species); 3) fish with swim bladders (or gas bubble structure) connected to or very close to the otolith ear that respond to sound pressure and particle motion (e.g. herring, cod species). This third group has the broadest and most sensitive hearing range and is therefore most sensitive to pressure changes. Over all extant fish species, there are fewer species in this third group than there are in the first and second groups that respond primarily to particle motion. Larval fish appear to have similar hearing ranges and behavioral startle responses to sound as do adults of the species (Hawkins and Popper, 2012).

Considering all these variables, effects of sound on adult fish can be generally divided into three groupings: physical and physiological injury; hearing impairment; and changes in behavior.

Barotrauma, due to rapid increase or decrease in pressure, can cause tissue injury in fish through rupture of swim bladder, damage to organs and tissues surrounding a ruptured swim bladder, or blood gasses coming out of solution. The more rapid the pressure change, the more likely the effects would be damaging to fish. Injury can also be caused by exposure to intense sounds. The type of injury (auditory nerve and hair cell damage) and ability to recover is variable, related to the magnitude and duration of the sound and the species of fish. If recovery from physical injury is slow or there is not recovery from an injury, fitness would be reduced and individuals would be more susceptible to physiological dysfunction, disease, and predation.

Hearing loss can occur in fish from continuous or impulsive sound. Injury to the auditory nerve, hair cells, or swim bladder can be temporary or permanent. A temporary change of hearing sensitivity may impede the ability of fish to detect important sounds in its auditory scene.

Behavioral impacts are most likely to occur in the 160- to 200-dB re 1 μPa range (Turnpenny and Nedwell, 1994). Typical behavioral responses of fish to introduced sound, such as sound from seismic surveys, include: balance disturbance (staying in normal orientation); disoriented swimming behavior; increased swimming speed; disruption or tightening of schools; disruption of hearing; interruption of important biological behaviors (e.g., feeding, reproduction); shifts in the vertical distribution (either up or down); and occurrence of alarm and startle behaviors (Table 4-27) (e.g., Dalen and Knusten, 1987; McCauley et al., 2000; McCauley, Fewtrell, and Popper, 2003; Pearson, Skalski, and Malme, 1992).

For migratory fish species, disturbance and displacement caused by noise and seismic surveys may disrupt migratory corridors, life-history behaviors, and access to habitat areas. Seismic surveys conducted in Federal waters close to State waters, where many fishes migrate through to spawning sites along the coast or in anadromous streams of the Arctic, may disrupt or impede their migrations as fishes attempt to avoid airgun emissions. The operation of more than one seismic operation simultaneously in an area may influence the distribution of some juvenile and adult fishes, inadvertently herding them away from suitable habitat areas (e.g., nurseries, foraging, mating, spawning, migratory corridors) and concentrating fish in less suitable habitats.

The frequency spectra of seismic-survey devices cover the range of frequencies detected by most fish (Pearson, Skalski, and Malme, 1992; Platt and Popper, 1981; Hawkins, 1981). Marine fishes are likely to detect airgun emissions 2.7-63 km (1.6-39 mi) from their source, depending on water depth (Pearson, Skalski, and Malme, 1992). Seismic-survey acoustic-energy sources can injure or kill eggs, larvae, and fry of some fishes occurring in close proximity to an airgun. The harm is generally limited to within 5 m (15 ft) from the airgun and greatest within 1 m (3 ft) of the airgun (e.g., Kostyuchenko, 1973; Dalen and Knutsen, 1987; Holliday et al., 1986; Turnpenny and Nedwell, 1994). Damage to fish from seismic emissions may develop slowly after exposure (Hastings et al., 1996).

The 2009 Arctic Fishery Management Plan (NPFMC, 2009) states:

"Underwater noise generates sound pressure waves that may disrupt or damage marine life. Oil and gas activities generate noise from drilling activities, construction, production facility operations, seismic exploration, and supply vessel and barge movements. Research suggests that the noise from seismic surveys associated with oil exploration may cause fish to move away from the acoustic pulse and display an alarm response (McCauley et al. 2000). This affects both fish distribution and catch rates (Engås et al., 1996). However, while there are few disagreements that noise from seismic surveys affects the behavior of fish, there are differences of opinion regarding the magnitude of those effects (Gausland 2003; McCauley et al. 2003; Wardle et al. 2001)."

Table 4-27. Fish–Noise and Seismic Sound Effects at Various Environments and Depths[1].

Noise and Seismic Effects on Fish Species at Various Depths[2]	Surfacewater	Midwater	Bottomwater	Seafloor Sediments	Estuarine and Freshwater
Ensonification of the fishes' soundscape from short pulse-high pressure airguns, low energy ensonification, vibrational noise, and percussive noise dispersed over broad areas, causing alternations in the natural soundscape for hearing and detecting natural vibrations	x	x	x	x	x
Behavioral effects: startle response, scattering, balance disturbance, hearing disruption, disoriented swimming, displacement, diversion from spawning grounds or migration corridors, avoidance swim responses by free-swimming fish and free-swimming prey. Behavioral responses could disrupt communication, feeding and reproductive behaviors, and detection of predators and prey	x	x	x	x	x
Physical and physiological effects: injury to swim bladders, lateral lines, otolith-ears, and internal organs of adult free-swimming fish from noise and seismic emissions in the immediate area. Organ injury could cause chronic degraded condition and mortality	x	x	x	x	x
Physical and physiological effects to epipelagic eggs, larvae, and young-of-year: Injury to organs; chronic degraded condition; and mortality to these early life stages that are unable to escape exposure of noise and seismic emissions	x	x			
Physical and physiological effects to benthic-obligated and territory-allegiant adult fish: injury to organs; chronic degraded condition; and mortality to species that are unable or less able to escape exposure to noise and seismic emissions			x	x	x
Physical and physiological effects to benthic-obligated juvenile, larvae, and egg life stages: Injury, chronic degraded condition, and mortality these early life stages that are unable to escape exposure of noise and seismic emissions			x	x	x
Physical effects to surfacewater fish: noise from icebreaker as ice breaks and moves (at relatively rapid rate) would cause startle responses, scattering, and disruption of feeding and reproductive behaviors by free-swimming adult fish and free-swimming prey; injury and mortality of weak-swimming and non-swimming fish life stages	x	x			
Noise and vibration disturbance effects are dependent on the distance from a sound source, the duration of the sound, the fish species, the species' life stage, and the behavioral ability of a species to avoid or minimize effects.	x	x	x	x	x

Note: [1]Summary of Effects of Noise and Seismic Emissions on Fish at Various Environments and Depths.
[2] Surface Water and Sea Ice (surface to ~10 m (33 ft) depth); Midwater (~10 m to ~ 3 m (33-9.8 ft) above seafloor); Bottomwater (up to ~3 m (9.8 ft) above seafloor); Seafloor Sediments (to 1 m (3.2 ft) below seafloor).

Exposure criteria for behavioral effects in fish and exposure criteria for the onset of physiological effects on fish had not been developed prior to 2012 (Hawkins and Popper, 2012). Interim criteria for physiological effects on fish from pile driving were developed by the Fisheries Hydroacoustic Working Group (FHWG, 2008) for the U.S. west coast.

According to Halvorsen et al. (2011, 2012), however, these FHWG criteria were based on incomplete studies. Instead they demonstrated that physiological response of juvenile chinook salmon to pile driving occurs at 16-23 db above the criteria levels reported by the FHWG in 2008.

A more extensive science-based set of sound-exposure guidelines were recently developed (Popper et al., 2014) based on the various ways fish species detect sound. Guidelines are presented for the following sound sources: seismic airguns, pile driving, explosives, low and mid-frequency naval radar, shipping and other continuous sounds. These guidelines are interim, based on research to date on the effects of noise on fishes, and would be refined every five years, or sooner, as additional applicable research is published.

The sound exposure guidelines (level of exposure for onset of effects) for fish in relation to seismic airguns (Table 4-28) were derived from various sources, including research on pile-driving effects. Table 4-28 shows the cumulative sound exposure levels (SEL_{cum}) for mortality, potential mortal injury, and impairment. The effects on behavior are described qualitatively, which is sufficient to inform the ensuing analysis.

Sound exposure guidelines (Popper et al., 2014) for shipping and other continuous noise are shown in (Table 4-29). Qualitative effects are presented for mortality, potential mortal injury, impairment, and behavior for all fish; the exception is quantitative guidelines that are available for impairment in fish with a swim bladder tied to hearing.

These 2014 guidelines by Popper et al. provide an important step in understanding and assessing the effects of sound on fish.

Table 4-28. Sound Exposure Guidelines (Onset of Effects from Airguns).

Table 7.4 Seismic airguns. Data on mortality and recoverable injury from Halvorsen et al. (2011, 2012a, c) based on 960 sound events at 1.2 s intervals. TTS based on Popper et al. (2005). See text for details. Note that the same peak levels are used both for mortality and recoverable injury since the same SEL_{ss} was used throughout the pile driving studies. Thus, the same peak level was derived (Halvorsen et al. 2011).

Type of Animal	Mortality and potential mortal injury	Impairment			Behavior
		Recoverable injury	TTS	Masking	
Fish: no swim bladder (particle motion detection)	>219 dB SEL_{cum} or >213 dB peak	>216 dB SEL_{cum} or >213 dB peak	>>186 dB SEL_{cum}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder is not involved in hearing (particle motion detection)	210 dB SEL_{cum} or >207 dB peak	203 dB SEL_{cum} or >207 dB peak	>>186 dB SEL_{cum}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder involved in hearing (primarily pressure detection)	207 dB SEL_{cum} or >207 dB peak	203 dB SEL_{cum} or >207 dB peak	186 dB SEL_{cum}	(N) Low (I) Low (F) Moderate	(N) High (I) High (F) Moderate
Sea turtles	210 dB SEL_{cum} or >207 dB peak	(N) High (I) Low (F) Low	(N) High (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Eggs and larvae	>210 dB SEL_{cum} or >207 dB peak	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low

Notes: peak and rms sound pressure levels dB re 1 μPa; SEL dB re 1 $\mu Pa^2 \cdot s$. All criteria are presented as sound pressure even for fish without swim bladders since no data for particle motion exist. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F).

Note: SEL is sound exposure level; TTS is temporary threshold shift. For fish in relation to seismic airguns from Popper et al. (2014). Reproduced here with permission from the Acoustical Society of America (Publication ASA S3/SC 1.4 TR-2014), and A. Popper. Sept. 2014.

Table 4-29. Sound Exposure Guidelines (Shipping and Continuous Sounds).

Table 7.7 Shipping and continuous sounds. For the most part, data in this table are based on knowing that fish will respond to sounds and their hearing sensitivity, but, as discussed in the text, there are no data on exposure or received levels that enable guideline numbers to be provided.

Type of Animal	Mortality and potential mortal injury	Impairment: Recoverable injury	Impairment: TTS	Impairment: Masking	Behavior
Fish: no swim bladder (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder is not involved in hearing (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder involved in hearing (primarily pressure detection)	(N) Low (I) Low (F) Low	170 dB rms for 48 h	158 dB rms for 12 h	(N) High (I) High (F) High	(N) High (I) Moderate (F) Low
Sea turtles	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) High (I) Moderate (F) Low
Eggs and larvae	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) Moderate (I) Moderate (F) Low

Notes: rms sound pressure levels dB re 1 μPa. All criteria are presented as sound pressure even for fish without swim bladders since no data for particle motion exist. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F).

Note: For fish in relation to shipping and continuous noise from Popper et al., 2014. Reproduced here by permission from the Acoustical Society of America (Publication ASA S3/SC 1.4 TR-2014), and A. Popper. September, 2014.

Exploration activities (Table 4-26) described in this Scenario would ensonify the surfacewater, water column, seafloor habitats, desalination brine and fish occupying those habitats. The effects would vary in time and space depending on the type of activity, the number of activities ongoing, the peak pressure of the sources, the rate of rise and decay of the sound sources, and the juxtaposition of the actions in relation to one another. These sound-altered conditions could affect fish through several pathways including: interference with sensory orientation and navigation, decreased feeding efficiency; disorientation; scattering of fish away from a food source; and redistribution of fish schools and shoals (Fay, 2009; Radford et al., 2010; Simpson, 2010; Slabbekoorn et al., 2010; Purser and Radford, 2011) (Table 4-27).

Literature pertinent to the effects of sound on fish has been published subsequent to the 2007 FEIS and 2011 SEIS (Table 4-30). An overview of salient results from this more recent literature is presented below.

Table 4-30. Effects of Sound on Fish: Literature Published Since 2007.

Fish and Effects of Sound: Topic Addressed	Date	Author, Publication
Bioacoustics and lateral line system of fishes; orientation and vocal communication of fish.	2008	Fay, Popper and Webb (eds) Fish Bioacoustics
Natural underwater soundscapes ("auditory scenes") as complex and information-rich auditory cues for fish	2009	Fay. Integrative Zoology
Types of human-generated sound in the aquatic environment and the effects on fish	2009	Popper and Hastings. Integrative Zoology
Effects of anthropogenic sources of sound on fish; a critical review of literature to date	2009	Popper and Hastings Journal of Fish Biology
Coastal habitats have distinct underwater acoustic signatures	2010	Radford et al. Marine Ecology Progress Series
Larval fish settlement influenced by recent acoustic cues from both natural and introduced sources	2010	Simpson et al. Behavioral Ecology.
Globally-rising underwater sound levels, particularly moderate long-duration sounds, affect fish	2010	Slabbekoorn et al. Trends in Ecology and Evolution
Acoustic noise induces attention shift and reduced foraging efficiency in fish	2011	Purser and Radford PLoS ONE
Ocean acidification erodes auditory behaviour in marine fish	2011	Simpson et al. Biology Letters
Fish select habitat using multiple cues, including auditory cues	2012	Huijbers et al. Ecology
Injury in chinook salmon from exposure to pile driving sounds	2012a, b, c	Halvorsen et al. PLoS ONE
Hydroacoustic impacts identified in fish from pile installation	2011	Halvorsen et al. (Nat'l Academies) Transportation Research Board
Effects of mid-frequency active sonar on fish hearing.	2012	Halvorsen et al. J. of Acoustical Society of America
Summary of research and research needs on sound effects on fishes in light of increasing anthropogenic noise	2012	Fay and Popper Brain, Behavior and Evolution
Environmental noise impacts on fish (a broad scope of topics on noise effects on fish addressed in 37 papers)	2012	Popper and Hawkins, (ed). Effects of Noise on Aquatic Life
Effects of noise on fish and fisheries from energy industry sound-generating activities	2012	Hawkins, Popper, and Normandeau Assoc. (extensive literature synthesis)
Pile driving sounds effects on fish inner ear tissues.	2013	Casper et al. Comparative Biochem. and Physiology
Effects of pile sounds on non-auditory tissues of fish	2013	Popper et al. OCS Report to DOI/BOEM
Cumulative effects of sound levels from multiple underwater anthropogenic sound sources in shallow coastal waters	2014	Pine, Jeffs, and Radford Journal of Applied Ecology
Disruption of fish communication by anthropogenic noise sources	2014	Radford, Kerridge, and Simpson. Behavioral Ecology.
Science-based guidelines developed on effects of noise on groups of fishes and turtles, defined by the way the species detect sound. Sound sources were considered and metrics defined to measure received levels.	2014	Popper, Hawkins, Fay, and others. Sound Exposure Guidelines for Fishes and Sea Turtles
Effects on two species of free-living coastal fish from repeated impulsive sounds; break up of fish schools, and avoidance swimming to different depths.	2014	Hawkins, Roberts, and Cheeseman J. of Acoustical Society of America

Note: Table summarizes science published since 2007 that is pertinent to evaluating effects of Lease Sale 193.

Summary of Noise Effects. Physical and physiological, hearing impairment, and behavioral effects on fish and fish prey would occur at all depths of the Leased Area marine environment. There could be chronic behavioral and chronic physiological effects to fish at less intense sounds, and acute effects for individuals within a few meters of a sound source that is above 180 db, or at 50 -90 db above the hearing threshold of the fish species.

Some fishes are of greater concern, due to their distribution, abundance, trophic relationships, or vulnerability in relation to noise and seismic emissions: (1) migratory fishes that are abundant seasonally in the nearshore zone that could be deterred or obstructed in reaching their reproductive feeding grounds, especially arctic char, least cisco, and broad whitefish; (2) fishes known to be particularly important in the trophic food web, including Arctic cod, capelin, and Pacific herring (an especially sensitive herring species); and (3) Pacific salmon in their marine and estuarine migration and staging periods of life due to their broad distribution and exposure to sound over their entire life cycles.

Migratory species at risk of spawning delays or disruptions include Pacific herring, capelin, Pacific salmon (mainly pink and chum salmon), cisco, broad whitefish, and Pacific sand lance. Pacific herring and Arctic cod are hearing specialists and are some of the most acoustically sensitive species occurring in the Leased Area. They are, therefore, some of the most likely fishes to exhibit displacement and avoidance behaviors due to noise and seismic activities.

Estuarine and freshwater fish would be affected by vessel noise and shorebase construction noise during exploration, and could include species such as: herring, capelin, rainbow smelt, sand lance, least cisco, Bering cisco, broad whitefish, humpback whitefish, Arctic cod, saffron cod, Arctic char, dolly varden, pink salmon, chum salmon, ninespine stickleback, starry flounder, Alaska plaice, and Bering flounder.

BOEM estimates that there would be no more than one survey per year. For the most part, sound effects would be localized and short-term.

Physical Presence

Presence and Transit of Vessels. Vessel traffic would occur throughout the exploration phase. Numerous vessel roundtrips would occur between the offshore facilities and the onshore facilities during exploration (Section 2.3.5). Icebreakers may be employed during all ongoing exploration drilling operations.

Vessels cause a path of physical disturbance that could affect the behavior of certain fish species, depending on the type of vessel, life history of the fish species, and depth of water. Free-swimming fish in the immediate vicinity of such vessels may avoid vessels. (The effects of vessel noise on fish are analyzed under “Noise and Seismic Emissions”). Fish species in the coastal and marine environments could be disturbed by the presence and passing of vessels during roundtrips from the offshore activities to the coastal staging areas (Table 4-31).

Table 4-31. Typical Effects of Vessel Transit on Fish during the Scenario.

Vessel Transit Effects on Fish Species at Various Depths	Surfacewater	Midwater	Bottomwater	Sediments	Seafloor Freshwater Estuarine and
Physical and Behavioral Effects: pressure waves from vessel hulls, cavitation of bubbles generated by vessel hull structures, towing of streamers and receivers,and vibrations from vessel pumps could displace fish and cause injury or mortality to non-swimming and weak swimming fish life stages and fish prey.	x	x			x
Physical and Behavioral Effects: icebreaking and ice management would disturb ice habitat on which some fish species depend for shelter and feeding; injury and mortality of ice-associated life stages of some fish species would occur	x				

Pressure waves from vessel hulls could displace fish in the surfacewater habitat and cause injury or mortality to non-swimming and weak swimming fish life stages and fish prey. Cavitation of bubbles generated by vessel hull structures and vibrations from vessel pumps could result in barotrauma injury and mortality of epipelagic non-swimming and weak swimming fish life stages and fish prey (Hawkins and Popper, 2012). Small fish life stages and small prey species could be impinged in streamers and vessel niches.

Exploration MODUs are attended by icebreakers during operations. Icebreaking and ice management would disturb ice habitat on which some fish species depend for shelter and feeding.

Summary: Effects of Vessels. Surfacewater (surface to ~10 m depth) marine fish species (considering all life stages) that would be most affected offshore include: herring, capelin, rainbow smelt, least cisco, Bering cisco, broad whitefish, humpback whitefish, Arctic cod, saffron cod, Arctic char, dolly varden, pink salmon, chum salmon, ninespine stickleback, Arctic alligatorfish, and Pacific sand lance.

Surfacewater estuarine, migratory, and anadromous species (considering all life stages) that would be most affected nearshore and in tidal riverine areas include: herring, capelin, rainbow smelt, sand lance, least cisco, Bering cisco, broad whitefish, humpback whitefish, Arctic cod, saffron cod, Arctic char, dolly varden, pink salmon, chum salmon, ninespine stickleback, starry flounder, Alaska plaice, and Bering flounder.

Discharges

The CWA regulates discharges into the waters of the United States. Discharges from oil and gas exploration facilities in the Chukchi Sea are regulated by EPA under NPDES (USEPA, 2012 a-e). The State of Alaska has been delegated these same authorities when activities are in State waters (up to three nautical miles from shore). The Vessel General Permit (VGP) for Discharges Incidental to the Normal Operation of Vessels authorizes discharges from vessels over 79 feet in length (EPA, 2013a) when they are operating in the territorial seas and as a means of transportation. There is also a small VGP that for vessels that are less than 79 feet long.

The discharge of drill cuttings and drilling muds associated with exploratory and developmental drilling activity, and drilling of service wells during production, would create increased turbidity and increased concentrations of total suspended solids in the water column. Drill cuttings and water-based drilling fluids are comprised of a slurry of particles with a wide range of grain sizes and densities, and various fluid additives may be water soluble, colloidal, or particulate in nature (Neff, 2005). Drill cuttings are particles of sediment and rock extracted from the bore hole as the drill bit penetrates the earth. Water-based drilling fluids consist of water mixed with a weighting agent (usually barium sulfate, $BaSO_4$) and various additives to modify the properties of the mud (Neff, 2005, Neff et al., 2010). Turbidity levels are generally expected to remain considerably below the EPA limit of 7,500 ppm suspended solids (NRC, 1983); however, in the immediate vicinity of exploratory drilling and anchor handling activities, turbidity may locally exceed the 7,500 ppm threshold. Effects on water quality resulting from increased turbidity would be local and would generally be restricted to the areas within 100 m (328 ft) of the drilling or anchor handling activity (NRC, 1983; Neff, 2005). Effects resulting from increased turbidity would be temporary and expected to end within a few days after drilling or anchor handling activity stops. Anticipated effects from pipeline construction would have similar results in turbidity from trenching and burying of pipelines during construction.

A previous exploration drilling operation on the Burger prospect was estimated to have disturbed 1,018 ft^2 of seafloor per well and each well cellar excavated 619 yd^3 of sediment (USDOI, BOEMRE, 2011g). Cuttings from the well cellar excavation were deposited on the seafloor below the temperature and salinity stratification layer. It is estimated that the maximum thickness of the sediment deposition onto the seafloor would be 10.4 ft (3.2 m) and the deposition would continue out to a horizontal distance of 449 ft (137 m) from the excavation site, where it would be 0.4 in (1 cm) thick. The excavation of a mud line cellar in a season would increase sediment, suspended solids, and turbidity in the lower water column above background levels, dependent upon the mineralogy and grain size of the sediments excavated. Currents and severe storm events could re-suspend and transport these newly deposited seafloor sediments (USDOI, BOEMRE, 2011g). After the deposition of materials from the disturbance of benthic surfaces ceases, it could take 4-8 years for the sea floor to return to a state where it is biologically usable for marine mammals, depending on the amount of material and deposition rate.

The ensuing downstream plume from cuttings dispersed into water is normally tens of meters wide and 100-900 m (328-2,953 ft) long. Disposal of drilling muds and cuttings would be as specified under conditions prescribed by the EPA's NPDES permit. Discharge of drilling muds and cuttings during exploration activities should not cause population-level effects to any marine mammals, either directly through contact or indirectly by affecting prey species. Material discharged during drilling and construction activities from the seafloor would be similar in composition to naturally-occurring seafloor sediments, and its contribution to turbidity from waves and currents would be about the same as the sediments existing at the seafloor surface before drilling activities (USDOI, BOEM, 2012). Experiments have shown the composition of deposited materials have an effect on recolonization of benthic communities, with natural sediments from disturbance of the benthic surface having less adverse effect on the recolonization rate than drilling muds, and water based drilling muds having less effect than synthetic muds (Trannum et al., 2011). Any effects would be localized primarily around the drilling unit because of the rapid dilution/deposition of these materials.

Fish that occur in the Leased Area would be affected each year by several types of discharges (Table 4-32), each regulated under the terms of NPDES General Permit issued by EPA. Types of discharges permitted under the current NPDES General Permit -2012-2017 NPDES General Permit for Oil and Gas Exploration Facilities on the Outer Continental Shelf in the Chukchi Sea (AK 28-8100) (EPA, 2012e) are provided in the table below.

Table 4-32. Permitted Types of Discharges.

Type of discharge	Depth of wastewater discharge into the Offshore Marine Environment
Water-Based Drilling Fluids and Drill Cuttings	Surfacewater, Midwater
Deck Drainage	Surfacewater
Sanitary Wastes	Surfacewater, Midwater
Domestic Wastes	Surfacewater, Midwater
Desalination Unit Wastes	Surfacewater
Blowout Preventer Fluid	Bottomwater, Seafloor sediments
Boiler Blowdown	Surfacewater (commonly directly at surface)
Fire Control System Test Water	Surfacewater (commonly directly at surface)
Non-contact Cooling Water	Surfacewater (commonly right on surface)
Uncontaminated Ballast Water	Surfacewater
Bilge Water	Surfacewater
Excess Cement Slurry	Bottomwater, Seafloor sediments
Muds, Cuttings, Cement at the Seafloor	Bottomwater, Seafloor sediments

Notes: Discharges permitted under the NPDES General Permit for exploration in the Chukchi Sea, 2012-2017 (NPDES #: AK 28-8100) and the Typical General Marine Water Depths that would be Affected by the Discharge.

Surface Water and Sea Ice (surface to ~10 m (33 ft) depth); Midwater (~10 m to ~ 3 m (33-9.8 ft) above seafloor); Bottomwater (up to ~3 m (9.8 ft) above seafloor); Seafloor Sediments (to 1 m (3.2 ft) below seafloor).

Table 4-33 presents an example volume of drill cuttings, drilling fluids, and well cellar sediment discharged into the water and on the seafloor for construction of exploration wells based on exploration discharge estimates presented in a Notice of Intent for exploration drilling in the Chukchi Sea submitted by a lessee to EPA, 2010.

Discharge of drilling muds and drill cuttings near the seafloor would cause increased suspended material in the lower water column which would eventually settle onto the seafloor, burying benthic habitat. The distance and depth to which the sediment would accumulate on the seafloor was modelled using the variables of water depth, depth of discharge, rate of discharge, and current speed. The EPA uses the model results when considering issuance of NPDES permits (EPA, 2012c).

Table 4-33. Exploration Well Sediment Discharged into Water and on Seafloor.

Type of Discharge	Estimated Discharge Volume (ft^3)		
	1 Well	4 Wells in One Year	40 Wells over Scenario
Cuttings only – drilling and mudline cellar construction over 38 days/well	22,554 ft^3	90,216 ft^3	902,160 ft^3
Drilling fluids and cuttings over 38 days/well	41,245 ft^3	164,980 ft^3	1,649,800 ft^3
Total for time period	63,799 ft^3: 1 Well	255,196 ft^3 4 Wells	2,551,960 ft^3 40 Wells

Notes: Example Volume of Drill Cuttings, Drilling Fluids and Well Cellar Sediment Discharged into Water and on Seafloor for Construction of Exploration Wells.

Estimates of discharges are based on the Notice of Intent for exploration drilling in the Chukchi Sea submitted by Shell, Inc. to EPA, 2010; an exploration well is based on operating 38 days/well. (1 bbl = 0.159 m^3 = 35 ft^3)

BOEM estimate, based on industry NOI submitted to EPA, that wastewater would be discharged through a caisson at less than 10 m (33 ft) below the sea surface; at this depth, wastewater would discharge above the temperature-salinity gradient, where it would mix with surface waters.

An estimated 45,000 barrels (252,656 ft^3) of cooling water per drill operation per day would be discharged at approximately 1-2 °C (1.8-3.6 °F) above ambient sea temperature at or very near the sea surface. It is estimated the temperature effect would dissipate within 50 m (164 ft) horizontally depending on several factors including: temperature above ambient, volume of discharge, rate of discharge, and degree of mixing in the discharge area (along current direction and speed) (EPA, 2012d).

Desalination brine, containing a slightly higher salinity and slightly higher dissolved constituents than seawater, would be discharged to the surfacewaters. Domestic wastewater and treated sanitary waste would introduce organic materials that would increase suspended solids and turbidity, and could cause temporary localized biological oxygen demand.

Excess cement discharged on the seafloor would also bury benthic habitat. Benthic fish would be exposed to total mercury and monomethyl mercury concentrations in surficial sediments from mercury-sulfide cuttings discharged to the seafloor. However, Fox et al. (2014) found no statistical differences in mercury in water or sediments in samples from 58 stations near sites of old exploratory wells in the Leased Area.

Strong-swimming fish exposed to the discharges in the upper water column may be capable of swimming away from plumes of wastewater discharge. Eggs, larvae, and juvenile stages of fish in the water column would have continued exposure to discharges due to their inability or limited ability for motility. Benthic fish would be particularly affected by the deposition of drilling fluids, drill cuttings and cement on to the seafloor. A summary of the effects of discharges on fish that would occur in the surfacewater, water column, and benthic habitats in the offshore environment is presented in Table 4-34.

EPA summarizes the effects of these exploration discharges on fish in their 2012 Biological Evaluation (EPA, 2012a):

> Temporary loss of habitat would also result from the discharge of effluents (e.g., drilling fluid and cuttings). It is anticipated that most solids from the drill fluids/cuttings would settle within 1,000 meters, with some smaller sediments settling as far as 1,400 meters (EPA, 2012). Deposition of these sediments could result in the burial of benthic organism (resulting in direct mortality). Increased turbidity could reduce light levels in areas directly adjacent to the drill, resulting in lowered productivity. Pollutants in the drill-fluid (e.g., barite, metals, etc…) could inhibit growth of, or result in the death of benthic or pelagic species that are exposed to these chemicals for long periods of time.

Table 4-34. Marine Discharge Effects on Fish Species at Various Depths.

Discharge Effects on Fish Species at Various Depths	Surfacewater	Midwater	Bottomwater	Seafloor Sediments
Physiological and physical effects: exposure of adults, eggs, and larvae to slightly elevated temperature near discharge of cooling water and slightly elevated salinity in vicinity of desalination brine discharge	x			
Physiological and physical effects: exposure of adults, eggs and larvae to low-level chemical constituents and suspended solids in vicinity of sanitary and domestic wastewater discharge	x	x		
Physical effects: increased turbidity from discharges could reduce light penetration for photosynthesis and primary production; effects dependent on size and weight of sediment particles, velocity of water, and location of the thermocline in relation to the discharge point	x	x		
Physical and behavioral effects: increased turbidity from discharges could cause reduced visibility for sight-feeders, dependent on size and weight of sediment particle and velocity of water; avoidance of turbidity plume; interruption of ongoing behaviors including communication, feeding and reproductive behaviors, and detection of predators and prey	x	x	x	x
Physical effects: burying of fish habitat from deposition of drill cuttings and other materials on seafloor			x	x
Physical and physiological effects: disturbance, injury, and mortality of benthic-obligate fish, eggs, and larvae due to discharges that bury fish unable to escape; clog gills and feeding and digestive structures of fish; expose fish to contaminants including mercury.			x	x
Physical effects: disturbance, injury, and mortality of epifauna prey in vicinity of activity due to discharges that bury prey, clog gills and feeding structures of prey, expose prey to contaminants including mercury			x	x

Notes: [1] Surface Water and Sea Ice (surface to ~10 m (33 ft) depth); Midwater (~10 m to ~ 3 m (33-9.8 ft) above seafloor); Bottomwater (up to ~3 m (9.8 ft) above seafloor); Seafloor Sediments (to 1 m (3.2 ft) below seafloor).

Vessels greater than 79 feet in length operating in the territorial seas during exploration, development, production, and decommissioning activities would require NPDES permit coverage for their incidental discharges under the VGP. Vessels less than 79 feet in length may be covered under the VGP, or may instead opt for coverage under the Small Vessel General Permit (sVGP) issued by EPA. These permits establish effluent limitations to control materials that contain constituents in the waste streams resulting from the activities of these vessels. Pollutant constituents in the VGPs may include nutrients, pathogens, oil and grease, metals, biochemical oxygen demand, pH, total suspended solids, aquatic nuisance species, and other toxic and non-conventional pollutants with toxic effects.

Summary of Effects of Discharges on Fish. The discharges from exploration activities would cause physical, physiological, and behavioral effects on fish. Discharges would affect different fish species, dependent on the type of discharge, the depth of the discharge and the fish species that inhabit that depth. Strong-swimming pelagic fish may be capable of avoiding some discharges. There would be acute effects (mortality) and chronic effects (injury that could lead to mortality) to weak-swimming and non-swimming life stages of fish in the surfacewater, midwater, bottomwater, and seafloor sediment environments.

Fish species (considering all life stages) that would be most affected in the surfacewater (surface to ~10 m (33 ft) depth) of the water column in the Chukchi Sea include: herring, capelin, Arctic cod, saffron cod, pink salmon, chum salmon, Arctic char, Pacific sand lance, and flatfish larvae.

Fish species (considering all life stages) that would be most affected in the midwater column (~10 m to ~ 3 m (9.8 ft) above seafloor) in the Chukchi Sea include: herring, capelin, pink salmon, chum salmon, Arctic cod, saffron cod, Arctic char, snailfish species, eelpout species, and prickleback species.

Fish species (considering all life stages) that would be most affected in demersal waters (bottomwaters, up to ~3 m (9.8 ft) above seafloor) in the Chukchi Sea include: Bering flounder, starry flounder, Alaska plaice, Arctic flounder, longhead dab, yellowfin sole, sculpin species, Arctic cod, saffron cod, Pacific sand lance, eelpout species, prickleback species, snailfish species, Bering wolffish, white-spotted greenling, Arctic char, and Arctic alligatorfish, Fish species that commonly occupy seafloor sediments in the Chukchi Sea include Bering flounder, starry flounder, Alaska plaice, Arctic flounder, longhead dab, yellowfin sole, sculpin species, and Pacific sand lance.

Habitat Alteration

Marine, Estuarine, and Freshwater Bottom Disturbance. Anchoring and weighing anchor by vessels may disturb the seafloor. Fish may be crushed or injured during the operations. Anchors may not hold fast under some conditions and drag across the seafloor, damaging fish habitat and prey for fish, particularly sessile organisms.

Anchoring in or near fragile areas, such as in or near kelp beds, would damage fish habitat. There are few kelp beds known to date in the Chukchi Sea, and these are located nearshore or in coastal lagoons. The magnitude of any damage to the seafloor would depend mainly on where anchors were placed, whether an anchor drags, and what an anchor might drag across. Direct impacts to the area of benthic fish habitat disturbed by anchoring would be small compared to the total area of benthic habitat available. Benthic fish and fish prey habitat would also be altered by cuttings discharges (analyzed above under Discharges and not repeated here).

Based on surface area disturbance estimates provided in proposed exploration plans submitted to BOEM by a lessee, Table 4-35 presents an example of the surface area disturbed for anchoring and mudline cellar construction.

Table 4-35. Surface Area Disturbed by Well Cellars and MODUs for Exploration Wells.[1]

Surface Area Disturbance	Approximate Surface Disturbance (ft^2)		
	1 Well*	Annual w/4 Wells/year	40 Wells over Scenario
Well cellar surface area	1,018 ft^2	4,072 ft^2	40,720 ft^2
Anchoring of drillship	32,432 ft^2	129,728 ft^2	1,297,280 ft^2
Total for time period	33,450 ft^2	133,800 ft^2	1,338,000 ft^2

Note: [1]Approximate Surface Area (ft^2) Disturbed by Excavating Well Cellars and Anchoring Drillships for Exploration Wells.
Estimates are based on exploration plans for the Chukchi Sea submitted by lessees to BOEM (1,000 ft^2 = 93 m^2;1 acre = 43,560 ft^2).

Production and development activities that would disturb the seafloor include: installation of OCS platforms; well drilling production and service; offshore oil pipeline and gas pipeline; plugging wells; wellhead equipment removed; offshore pipelines decommissioned (cleaned, plugged); platform disassembled; and seafloor restoration.

The effects of seafloor disturbance on benthic fish and fish prey include loss of benthic habitat, decreased visibility in demersal waters, injury, and mortality (Table 4-36). Seafloor disturbance is not expected to affect the upper mid-to-upper water column, depending on the depth of the water. The fish species (considering all life stages) most likely affected by seafloor disturbance include: Arctic flounder, Bering flounder, starry flounder, Alaska plaice, longhead dab, yellowfin sole, sculpin species, Pacific sand lance, saffron cod, Arctic cod, Bering wolffish, eelpout species, prickleback species, snailfish species, white-spotted greenling, and Arctic alligatorfish.

Onshore activities that could alter estuarine and freshwater bottom habitat construction of a shorebase facility, construction of a processing facility, installation of an onshore oil pipeline, and installation of a natural gas pipeline. The fish species that would be most affected include herring, capelin, rainbow smelt, sand lance, least cisco, Bering cisco, broad whitefish, humpback whitefish, Arctic cod, saffron cod, Arctic char, dolly varden, pink salmon, chum salmon, ninespine stickleback, starry flounder, Alaska plaice, and Bering flounder.

Table 4-36. Seafloor Disturbance Effects on Marine, Estuarine and Freshwater Environments.

Marine, Estuarine and Freshwater Bottom Disturbance: Physical and Behavioral Effects on Fish Species at Various Depths	Surfacewater	Midwater	Bottomwater	Seafloor Sediments	Estuarine and Freshwater
Anchoring of drillships, setting footings, anchoring of vessels, and well cellar construction would disturb, damage, and bury fish habitat and fish prey habitat.			x	x	
Anchoring of drillships, setting footings, anchoring of vessels, and well cellar construction would cause injury and mortality of benthic-obligate fish life stages and prey of fish.			x	x	
Increased turbidity and decreased visibility for sight-feeding fish in vicinity of seafloor disturbance.			x	x	
Onshore construction of pipeline and facilities could disturb, damage, and bury fish habitat and fish prey habitat; cause injury and mortality of benthic-obligate fish life stages, alter fish passage; and alter channel morphometry.					x

Water Withdrawals. In 2012, EPA added cooling water intake structure requirements to the NPDES General Permit for exploration in the Chukchi Sea (EPA, 2012f). USDOI, BLM (2012, Section 4.3.4.2, p.117 and Section 4.3.7) provides information on the general effects of freshwater withdrawal on fish and fish habitat and is incorporated by reference.

Seawater would be withdrawn during exploration activities for non-contact, once-through cooling of equipment, evaporative cooling, dilution of effluent heat content, and for desalination for freshwater supplies. Typical volumes of cooling water and desalination withdrawals for exploration, development, production, and decommissioning activities are presented in Table 4-37.

Table 4-37. Cooling and Desalination Water Withdrawals per Exploration Well.

Water Withdrawal Criteria	1 Well	4 Wells (Typical Year)	40 Wells (Full Scenario)
Maximum intake velocity permitted (NPDES Permit)	≤0.5 ft/s	≤0.5 ft/s	≤0.5 ft/s
Typical cooling water withdrawal for exploration well (based on 38 days of operation /well)	9,348,281 ft^3	37,393,124 ft^3	373,931,240 ft^3
Typical desalination water withdrawal for exploration well (based on 38 days of operation /well)	25,967 ft^3	103,868 ft^3	1,038,680 ft^3
Total water withdrawals for cooling water and desalination water for exploration well (based on 38 days of operation /well)	9,374,248 ft^3	37,496,992 ft^3	374,969,920 ft^3

Note: Approximate Non-contact Cooling Water and Desalination Water Withdrawals for Exploration Drilling over 38 Days/Well.

Estimates of volumes of water withdrawals are based on Notice of Intent for exploration drilling in the Chukchi Sea submitted by a lessee to EPA (2010a, b, c) (1 bbl = 0.159 m^3 = 35 ft^3).

Intake velocities would be limited to 0.5 ft/s (≤0.15 m/s by the current NPDES permit (EPA, 2012e) which would help to limit injury and mortality. The NPDES permit also calls for best technology available for location, design, construction, operation and capacity of the cooling water intake structure.

Life stages of various species of marine fish would be affected by water withdrawals during all phases of activities. Fish eggs, larvae, and age-0 fish that pass through the hydraulic zone-of-influence of the facility's intake structure could be impinged or entrained leading to injury or mortality. Arctic cod early life stages and flatfish larvae would be particularly affected by water withdrawals.

Water may also be withdrawn from nearshore marine waters, lakes, ponds, and rivers for onshore construction and maintenance activities (USDOI, BLM, 2012). The State of Alaska has established water quality standards for designated uses of marine and fresh water (www.dec.state.ak.us/water/wqsar). In the exploration and development phase, winter construction of the overland oil pipeline is expected to begin. It is anticipated that this would be accomplished, at least initially, with ice roads and pads. Potential effects from water withdrawals from ponds and lakes include reduced water levels; reduced critical overwintering habitat; decreased flow among lake systems; decreased oxygen availability; and entrainment of young life stages in intake devices. Injury and mortality to fish, particularly sensitive early life stages, to water withdrawn from lakes, ponds, and nearshore waters would occur.

Potential for Introduction of Aquatic Invasive Species. Based on knowledge to date, no marine invasive (i.e., non-native species that cause harm) species occur in the U.S. Chukchi Sea, although a non-native bivalve species was found in the southeastern Chukchi Sea on a transect from the Russian Siberian Peninsula toward Point Lay (Sirenko and Gageav, 2007). For purposes of this analysis, the introduction of aquatic invasive species as a result of oil and gas activities are considered as a hypothetical potential effect.

Aquatic invasive species can be introduced through a variety of vectors including fouled vessel hulls, ballast-water discharge, vessel dockage to land, and equipment placed overboard (e.g., anchors, seismic survey equipment, and sound receiving equipment). The resulting effects can occur through overtaking habitat (e.g., encrusting surface areas), competing for food sources, competing for spawning grounds, preying on native species, or introducing pathogens. Such effects can lead to ecological changes in community structure, decrease in genetic diversity, and shifts in abundance and diversity of native species. Ultimately, negative impacts on native species of cultural or economic importance can occur. Predicting what species would invade, and where and how the invasion might occur is difficult. Some non-native species, although initially considered to pose no invasive threat, may exhibit explosive population growth long after their initial establishment in a new environment, particularly as climate conditions change at the new site.

Aquatic invasive species in other northern seas are described here as a proxy for potential effects (Table 4-38) in the Chukchi Sea. Most of these documented aquatic invasive species in northern seas to date are crab species, which can in turn can affect fish and fish prey. The potential effects are analyzed here in relation to fish and fish habitat but have potential to affect other resources analyzed in this Second SEIS.

Table 4-38. Literature on Possible Arctic Sea Marine Invasive Species.[1]

Potential for Marine Invasive Species: Topic Addressed	Date	Author, Publication
Oil rigs and associated equipment can be vectors for invasive species given the many niche areas and the slow speed of a rig towed in water	2009	Commonwealth of Australia
Potential pathways for and effects of invasive species associated with oil and gas equipment and activities	2010,	International Association of Oil and Gas Producers
Semisubmersible oil platforms are notable vectors for transporting non-indigenous species across biogeographical boundaries	2010	Yeo et al.
Non-native species on slow-moving vessels (barges and tugboats) most fouled in niche areas of the hull and where the anti-fouling paint condition was poor	2010	Hopkins and Forrest
Jack-up rigs as potential vectors for marine invasive species; dry-docking may mitigate potential of live organisms	2012	URS Alaska
Emergence of new Arctic trade routes will probably change the global dynamics of marine invasive species, especially in coastal regions	2014	Miller and Ruiz
Underwater vessel noise may promote settling of biofouling organisms	2014	McDonald et al.
Risk of ballast-borne marine invasive species to coastal Alaska	2014	Verna
Patterns of biological invasions in marine polar ecosystems	2009	Ruiz and Hewitt
Non-native colonial tunicate introduced to Alaska likely via previously used out-of-state dock and pier timbers, or ballast water discharge	2011, 2012	Cohen et al., Simkanin et al.
Non-native Chinese mitten crab discovered in the White Sea, Russian Arctic	2010	Pettersen
Non-native red king crabs introduced to Russian Barents Sea aggressively expands, preys on and competes with native species	2005	Jorgensen
Highly adaptive non-native green crab northward movement via intracoastal ship ballast water discharges have established in British Columbia	2005	Jamieson et al.

Note: [1]Literature Indicating the Potential and Type of Effects from Marine Invasive Species that Could Occur in Arctic Seas.

The International Association of Oil and Gas Producers (OGP) describe the potential pathways for and effects of aquatic invasive species associated with oil and gas equipment and activities (OGP, 2010, 2012). The likelihood of organisms to attach to a vessel or rig from outside Alaska and transport to the Chukchi Sea depends on the speed of a vessel, the type of surface areas, the number and size of niche areas, the duration of transit, and the route of a vessel. Oil rigs and associated equipment can be vectors for aquatic invasive species given the many niche areas and the slow speed necessary to tow a rig (Commonwealth of Australia, 2009).

Biofouling was found on slow-moving vessels (barges and tugboats) most commonly in niche areas of the hulls and places where the condition of anti-fouling paint was poor (Hopkins and Forrest, 2010). Yeo et al. (2010) identified non-native species attached to a semisubmersible oil platform dry-docked for hull cleaning in Singapore; of the non-native species found, two species of crab were known to be invasive species in other parts of the world.

The risk of ballast-borne marine species invasions in coastal Alaska was investigated by Verna (2014). The study reports that coastal Alaska receives about 14 million metric tons of ballast water annually from 49 different ecoregions. Crude oil tankers in coastwise trade were identified as the dominant type of vessel traffic discharging ballast-water in Alaska coastal waters. Of the major Alaska ports evaluated in the study, the Red Dog port on the Chukchi Sea showed the third highest risk for invasion by marine species in coastal Alaska, after Port of Valdez and the Drift River Terminal. With decreasing sea ice, new trans-arctic shipping routes would increase the potential for introduction of invasive species in northern seas (Smith and Stephenson, 2013).

Across all vectors and pathways, climate change can influence the dispersal of invasive species, presenting the potential for increased risk of invasion of non-native species (EPA, 2008, Rahel and Olden, 2008, Hellman et al., 2008). Ice cover, cold sea temperatures, ocean salinity and river discharge are important factors in the U. S arctic that may be influenced by climate change and therefore act synergistically with non-native species, increasing the risk of invasion.

Accidental Oil Spills

Small Refined Oil Spills. Small refined spills (<1,000 bbl,) have the potential to occur during open-water season in the exploration phase. Small refined spills onboard a vessel or on a platform may be contained. Small spills reaching the water may be contained in the water by booms or absorbent materials. The impacts to fish from small refined oil spills include surfacewater quality degradation and potential toxicity.

Development

Activities in the development phase are presented in Table 4-39, and include: OCS platforms; production and service well drilling; installation of offshore oil pipeline and gas pipeline; installation of onshore oil pipeline and gas pipeline; construction of a shorebase and processing facility, and vessel traffic. Because development activities would affect different depths of the marine environment and different environments (marine, estuarine, freshwater), it follows that different fish species and fish life stages that occur at those depths and in those particular environments may be more affected.

Table 4-39. Type of Development Activity and the Environments Affected by the Activity.

Type of Development Activity	Environment and Depth[1] Affected			
	Marine: Surface Water, Ice	Marine: MidWater Column	Marine: Bottomwater and Seafloor Sediments	Estuarine and Freshwater
Installation of offshore platforms	X	x	x	
Drilling for production and service wells	X	x	x	

Type of Development Activity	Environment and Depth[1] Affected			
	Marine: Surface Water, Ice	Marine: MidWater Column	Marine: Bottomwater and Seafloor Sediments	Estuarine and Freshwater
Installation of offshore oil pipeline and gas pipeline	X	x	x	
Installation of onshore oil pipeline and gas pipeline				x
Construction of a shorebase, processing facility and waste facility				x
Vessel traffic	X	x	x	x
Discharges (operations and vessels)	X	x	x	x

Note: [1] Surface Water and Sea Ice (surface to ~10 m (33 ft) depth); Midwater (~10 m to ~ 3 m (33-9.8 ft) above seafloor); Bottomwater (up to ~3 m (9.8 ft) above seafloor); Seafloor Sediments (to 1 m (3.2 ft) below seafloor)

Noise: Fish would be affected by noise in the marine, coastal, and onshore/freshwater environments during development. The effects of noise on fish in development would be of the same type as those analyzed in detail in the analysis of the exploration phase.

Physical Presence: Fish would be affected by the physical presence of vessels, vessel traffic, platforms, and pipelines in the marine, coastal, and freshwater environments during the development phase. Numerous vessel roundtrips would occur between the OCS facilities and the onshore facilities throughout development. Icebreakers would be employed in the development phase during autumn and early winter. The effects of the presence and movement of vessels on fish are analyzed under Exploration Phase. The effects of the presence of platforms and pipelines may provide additional sheltering areas for fish or could cause obstruction to movement for some fish species.

Discharges: Discharges from development activities commonly include the type of discharges identified in exploration drilling operations plus other discharges, including water clarifying agents and disinfection agents. A development operation would require an Individual NPDES Permit specific to the type of activities and discharges. Discharge effects on fish are analyzed above in under Exploration Phase.

Habitat Alteration: Marine bottom habitat alteration would occur during the development phase due to anchoring, development well drilling, anchor field development, and satellite field development. Estuarine and freshwater fish habitat would be altered during development by the following activities: installation of an onshore oil pipeline, installation of an onshore gas pipeline, construction of a shorebase, and construction of onshore processing and waste facilities. The effects of these types of activities on fish are analyzed above in the Exploration Phase section.

Water Withdrawals: Water demand and withdrawals would occur throughout the development phase. The effects of water withdrawal on fish are analyzed in the Exploration Phase section.

Accidental Small and Large Oil Spills

Development activities would present the potential for small refined spills, small crude spills, small condensate spills, and large (≥1,000 bbl) oil spills. During development, small refined spills, small crude oil spills, and small condensate spills could occur any time of the year. The effects of a small refined spill on fish are analyzed under exploration.

A small crude oil spill or condensate spill during open water would introduce hydrocarbon contaminants of various weights into the surface water, causing temporary decreases in water quality and conditions for toxicity for fish at the surface. Early life stages that occur at the surface, such as Arctic cod eggs and larvae in later winter, spring and early summer, would be particularly affected. Lighter weight hydrocarbon fractions (such as condensates) would volatilize more rapidly than heavier hydrocarbon fractions. Lighter weight fractions, however, would cause greater acute toxicity conditions for early life stages of fish that occur on the surface. During ice season, small crude oil and condensate spills could occur and cause fish to disperse from an area of ice used for feeding and shelter, or cause acute toxicity to weak-swimming or non-swimming early life stages at the surface.

Two large spills—of 1,700 bbl crude or condensate oil from a pipeline, and 5,100 bbl crude, diesel or oil condensate from a platform—could potentially occur during development. These spills could affect marine, estuarine, tidal riverine, and freshwater fish species depending on the location, volume, and trajectory of the spill, and the time of year it occurs.

The chemistry of sea water changes at the surface continuously as an oil spill on the surface changes. Individual hydrocarbon compounds at the surface of an oil spill would decrease in concentration through volatilization and other processes, depending on the weight of the hydrocarbon compound. Dissolution and accumulation of hydrocarbon compounds in the water underlying the oil would occur in a large oil spill. Concentrations of dissolved oil that move from the surface water into the water column could then spread horizontally in the water column. The effects of a large crude oil spill are analyzed in more detail in the subsection below, "Impacts of the Scenario Through Time."

Production and Decommissioning

Activities in the production phase are presented in Table 4-40. The type of production activities that could cause impacts to fish include production and service well drilling. Because production activities would affect different depths of the marine environment and different environments (marine, estuarine, freshwater), it follows that different fish species and fish life stages that occur at those depths and in those particular environments may be more affected.

Table 4-40. Type of Production Activity and the Environments Affected by the Activity.

Type of Production Activity	Environment and Depth[1] Affected – Production			
	Marine: Surface Water, Ice	Marine: Mid-Water Column	Marine: Bottomwater and Seafloor Sediments	Estuarine and Freshwater
Oil production	x	x	x	
Gas production	x	x	x	
Pipeline offshore – oil and gas transport			x	x
Pipeline onshore – oil and gas transport			x	x
Vessel traffic	x	x	x	x
Discharges (vesssels and operations)	x	x	x	x

Noise: Fish would be affected by noise in the marine, coastal, and onshore/freshwater environments during production. The effects of noise on fish in production would be of the same type as those analyzed in detail under Exploration Phase.

Physical Presence: Fish would be affected by the physical presence of vessels, vessel traffic, platforms, and pipelines in the marine, coastal, and freshwater environments during production. Vessel traffic would occur throughout the production phase. Numerous vessel roundtrips would occur between the OCS facilities and the onshore facilities during production. Icebreakers may be employed in the production phase during autumn and early winter. The effects of the presence and movement of vessels on fish are analyzed above under Exploration Phase. The effects of the presence of platforms and pipelines may provide additional sheltering areas or could cause obstruction to movement for some fish species.

Discharges: Discharges from production activities commonly include the type of discharges identified in exploration drilling operations plus other discharges, including produced waters, water clarifying agents and disinfection agents. A production operation would require an Individual NPDES Permit specific to the type of activities and discharges. Discharge effects on fish from production would be of the same type as those analyzed in detail under Exploration Phase, and additional possible effects from produced waters discharge if and where permitted.

Habitat Alteration: Marine bottom habitat alteration would occur during production due to anchoring, any additional offshore construction and maintenance of platforms and pipelines, Estuarine and freshwater fish habitat could be altered during production by operation and maintenance of: onshore oil and onshore gas pipelines; shorebase facilities; and onshore processing and waste facilities. The effects of these types of habitat altering activities on fish are analyzed above under the Exploration Phase.

Water Withdrawals: Water demand and withdrawals would occur throughout the production phase. The effects of water withdrawal on fish are analyzed under Exploration Phase.

Small Refined Oil Spills: Small refined oil spills would occur during production. The effects of small refined oil spills on fish are analyzed under the Exploration Phase.

Large Oil Spills: Large oil spills could occur during the production phase. The effects of large oil spills on fish are analyzed under the Development Phase.

Decommissioning activities are presented in Table 4-41. Because decommissioning activities would affect different environments and at different depths, it follows that different fish species and fish life stages that occur in those environments and at those depths would be more affected.

Table 4-41. Decommissioning Activity Types and Environments Affected.

Type of Decommissioning Activity	Environment and Depth[1] Affected - Decommissioning			
	Marine: Surface Water, Ice	Marine: MidWater Column	Marine: Bottom-water and Seafloor Sediments	Estuarine and Freshwater
Wells plugged			x	
Wellhead equipment removed	x			
Processing module removed from platforms	x			
Offshore pipelines decommissioned			x	
Onshore pipelines decommissioned				x
Platform disassembled	x	X	x	
Seafloor restored			x	
Vessel traffic	x	X	x	X
Discharges (vessels and operations)				

Noise: Fish would be affected by noise in the marine, coastal, and onshore/freshwater environments during decommissioning. The effects of noise on fish in production would be of the same type as those analyzed in detail under Exploration Phase.

Physical Presence: Fish would be affected by the physical presence of vessels, vessel traffic, and activities to disassemble platforms. Vessel traffic would occur throughout the decommissioning phase. Numerous vessel roundtrips would occur between the OCS facilities and the onshore facilities during decommissioning. The effects of the presence and movement of vessels on fish are analyzed above under Exploration Phase. The disassembly of platforms and related structures may remove structural habitat to which some species of fish had accommodated.

Discharges: Discharges from decommissioning activities would depend on the specific activity. A decommissioning and reclamation operation would likely require an Individual NPDES Permit specific to the type of activities and discharges. Discharge effects on fish from decommissioning, particularly any seafloor excavation activities, would be similar to those discharge effects analyzed under Exploration Phase.

Habitat Alteration: Marine bottom habitat alteration would occur during decommissioning platform and structure removal, and seafloor reclamation activities. Estuarine and freshwater fish habitat could be altered during decommissioning activities that may occur onshore associated with decommissioning OCS facilities. The effects of these types of habitat altering activities on fish are analyzed under the Exploration Phase.

Water Withdrawals: Water demand and withdrawals would occur throughout the decommissioning phase. The effects of water withdrawal on fish are analyzed under Exploration Phase.

Accidental Small and Large Oil Spills and Gas Releases

Small refined spills, small crude oil spills, and small condensate spills could occur during production. Large spills of crude oil, condensate, or diesel (≥1,000 bbl) could also occur during development. Gas releases at OCS facilities and offshore and onshore gas pipelines are possible during the oil and gas production phase. Impacts to fish from small spills, large oil spills, and gas releases are analyzed under exploration and development phase.

In the event of a natural gas release from an offshore pipeline or well, methane would be released into the water and proceed to rise through the water column as a function of depth of release (pressure), volume of release, rate of release, water temperature, and ice presence or absence. When released at depth, the water quality would be altered temporarily. In deeper, colder waters, some of the natural gas would enter the water as a water-soluble fraction. Fish in the immediate vicinity of the rupture could experience hearing and internal organ injuries from percussive waves and bubble cavitation. Upon reaching the surface the gaseous methane would react with air, forming CO_2 and water which would then disperse into the atmosphere. The higher concentration of CO_2 near the surface would affect chemical and biological processes and potentially cause lethal effects to sensitive life stages of fish at the surface.

Natural gas releases from an onshore pipeline would not affect fish unless the pipeline was close to the water surface and causes percussive air waves that affected sensitive life stages at the surface.

Impacts of the Scenario through Time

This section analyzes imapcts to fish as they occur over the 77 years of the Scenario. The analyses address the particular oil and gas activities that would occur during each phase and analyzes their impacts. The analyses consider the effects of ongoing climate change, and how the IPFs of the Scenario could affect fish species in a shifting baseline. Fish numbers and distributions would likely shift over time in response to changes in areas used for various life history strategies. Some fish species species could benefit from creation of new habitats, or changes in prey distribution and abundance. Other species could be adversely affected by climate change. None of the IPFs addressed below should have appreciable direct interactions with climate change effects.

Exploration (Years 1-5)

During Years 1-5, fish would be affected by exploration activities from noise, physical presence of vessel traffic between offshore and shore facilities, shorebase construction activities, discharges, habitat alteration, water withdrawals, small refined oil spills, and the potential risk of introducing aquatic invasive species. Fish in offshore, nearshore, and coastal riverine environments at all depths would be affected by these activities during exploration during Years 1-5; however, these effects would likely be short-term and localized.

Fishes of concern that would be affected during Years 1-5 due to their distribution, abundance, trophic relationships, or vulnerability include: diadromous fishes that are abundant seasonally in the nearshore zone, especially arctic char, least cisco, and broad whitefish; Arctic cod eggs, larvae, and age-0; intertidal-estuarine-nearshore spawning and/or rearing fishes, particularly capelin, Pacific herring, and sand lance; and Pacific salmon in their marine and estuarine migration and staging periods of life.

Some mortality of benthic marine fish (various life stages) would occur through injury or burial as a result of seafloor excavation and bottom water discharges (e.g. benthic-obligate life stages of flatfish species, sculpin species, eelpout species, prickleback species, snailfish species, sand lance, saffron cod). Mortality of marine surfacewater eggs, larvae, and juvenile fish would occur as a result of water withdrawals, surfacewater discharges, icebreaking, cavitation, vibrations, and entrainment (e.g.herring, capelin, Arctic cod, saffron cod, pink salmon, chum salmon, sand lance). Some mortality of surfacewater eggs, larvae, and age-0 fish would occur as a result of small refined oil spills. The combined mortalities are not likely to affect the populations of these species.

Behavior of pelagic fish would likely be affected by noise from several sources during open-water seasons. Benthic fish habitat would be altered and the effects would be localized and dependent upon the noise source. Fish and fish habitat could also be affected negatively during exploration if an aquatic invasive species was introduced.

Small refined-oil spills (<1,000 bbl) could occur during exploration activities. These spills could result from refueling activities at sea during geological and geophysical activities (geohazard, geotechnical or marine seismic surveys), during exploration drilling activities, or during construction of exploration bases on land. The estimated total, as well as the annual number and volume of small refined oil spills during exploration activities are displayed in Tables 4-1 and 4-2.

Years 1-5: Effects of Small Refined Spills (<1 to 50 bbl) on Fish. Marine, coastal, tidal riverine and freshwater fish are affected as follows:

- Small refined spills would introduce hydrocarbons to surfacewater of marine, coastal, tidal riverine, or fresh water fish habitats.
- Water quality characteristics in the surface layer in the immediate area of the spill would be degraded for hours up to three days
- Potential acute toxicity to fish, particularly early life stages at the surface, would be temporary and localized. Arctic cod eggs and larvae in later winter, spring, and early summer would be locally affected.
- Small spills would be localized and temporary, and may cause fish to interrupt behaviors and disperse from an area used for feeding, reproduction, or shelter.
- Hydrocarbon compounds would dissolve and accumulate in water underlying a spill, depending on environmental conditions, and could affect fish in the immediate vicinity.

The effects of small refined spills during Years 1-5 would be localized and short-term. These effects would be limited by requirements such as spill-catchment equipment on vessels, exploration rigs, and at land facilities; deployment of booming equipment during offshore fuel transfers; and automatic shutdown of fuel lines triggered by decreased pressure.

Overall, the impacts on fish (considering all life stage of all fish species) during Years 1-5 would be minor. Although mortality of individuals would occur, and there could be potential for introduction of invasive species, the effects on fish would be localized and short-term. As stated above, the effects of climate change would be on-going in this and subsequent phases. While the magnitude of potential effects from the Scenario on fish is not anticipated to change, climate change could affect species composition, number and distribution.

Exploration and Development (Years 6-9)

During Years 6-9, fish could be affected by exploration and development activities from noise, physical presence of vessel traffic, discharges, habitat alteration, water withdrawals, construction of platforms and pipelines, icebreaking, small refined oil spills, large oil spill(s), and the potential risk of introducing aquatic invasive species. Fish in offshore, nearshore, coastal riverine, and freshwater environments at all depths would be affected by the various exploration and development activities during Years 6-9.

Mortality of benthic marine fish would occur through injury or burial as a result of seafloor excavation, construction on seafloor, platform installation, pipeline trenching and burial, and bottom water discharges (e.g. benthic-obligate life stages of flatfish species, sculpin species, eelpout species, prickleback species, snailfish species, sand lance, saffron cod). Mortality of marine surfacewater eggs, larvae, and juvenile fish would occur as a result of water withdrawals, surfacewater discharges, icebreaking, cavitation, vibrations, and entrainment (e.g. herring, capelin, Arctic cod, saffron cod, pink salmon, chum salmon, sand lance). Mortality of surfacewater eggs, larvae, and age-0 fish would occur as a result of small refined oil spills. The combined mortalities are not likely to affect the populations of these species.

Benthic marine fish habitat would be altered and the effects would persist for more than one year. Fish and fish habitat could also be potentially affected during exploration and development during Years 6-9 by introduction of an aquatic invasive species. Noise from cumulative exploration and development sources would affect fish behavior over this period.

Onshore activities (habitat alteration, water withdrawals, noise, small fuel spills, discharges, and runoff) could affect freshwater fish and fish habitat (Arctic grayling, round whitefish, sheefish, lake trout, burbot, northern pike, Alaska blackfish, slimy sculpin).

A large oil spill (described below) would cause chronic and acute effects, particularly on young life stages and coastal fish if oil made landfall. If oil landed at an anadromous water entry point during spawning season, a distinct population unit of salmon could be reduced or lost. A large oil spill making land fall during spawning season could affect the populations of these sensitive coastal and anadromous species in subsequent years. If booms were in place at stream mouths before oil came to shore, potentially there would be less harm to the populations of those particular anadromous streams.

The reasonably foreseeable potential for small refined spills (<1,000 bbl) continues in the exploration and initial development phases (e.g. facility construction and operation, and pipeline installation). The effects of small refined spills are described above under Years 1-5. During Years 6-9, there would be an increased number of small spills compared to Years 1-5 but a decrease in the estimated average size of a small refined spill. The type of effects in Years 6-9 would be the same as those described in Years 1-5, though the magnitude of effects would be greater due to the greater number of small spills from a greater number of oil and gas activities ongoing.

Based on the criteria outlined in Section 4.2, the impacts on fish (considering all life stage of all fish species) from routine oil and gas activities would be minor. Although mortality of individuals would occur, and there could be potential introduction of invasive species, the effects on fish would be localized and short-term. In the event of a large oil spill, effects would be moderate because they would be widespread, long-lasting, mortality of individuals would occur, and there would be increased potential for introduction of invasive species.

Exploration, Development, and Production (Years 10-25)

During Years 10-25, fish would be affected by exploration, development, and production activities from noise, physical presence of vessel traffic, discharges, habitat alteration, water withdrawals, the operation of up to four MODUs at once, construction of platforms, construction of onshore and offshore pipelines, small refined oil spills, large oil spill(s), and the potential risk of introducing aquatic invasive species. This 15-year period would potentially cause the greatest number of activities and effects in the Scenario. Fish in offshore, nearshore, coastal riverine, and freshwater environments at all depths could be affected by the various exploration, development, and production activities in Years 10-25.

Noise from exploration, development, and production sound sources would potentially affect fish over this 15-year period. Fish and fish habitat could also be affected negatively during Years 10-25 if an aquatic invasive species was introduced.

Onshore activities (habitat alteration, water withdrawals, noise, small fuel spills, discharges, and runoff) could affect freshwater fish and fish habitat (Arctic grayling, round whitefish, sheefish, lake trout, burbot, northern pike, Alaska blackfish, slimy sculpin).

Mortality of marine benthic fish (various life stages) would occur through injury or burial as a result of seafloor excavation, construction on the seafloor, pipeline trenching and burial, and bottom water discharges (e.g. benthic-obligate life stages of flatfish species, sculpin species, eelpout species, prickleback species, snailfish species, sand lance, saffron cod). Benthic fish habitat would be altered and the effects would likely persist for more than one year. Mortality of marine surfacewater eggs, larvae, and juvenile fish would occur as a result of water withdrawals, surfacewater discharges, icebreaking, cavitation, vibration, and entrainment (e.g. herring, capelin, Arctic cod, saffron cod, pink salmon, chum salmon, sand lance). The combined mortalities from these sources during Years 10-25 are not likely to affect the populations of these species.

Small (<1,000 bbl) oil spills could occur during exploration, development, or production. Several hundred small oil spills are assumed to occur during the 77-year Scenario. In Year 10, as oil development and production begin in earnest, large (≥1,000 bbl) oil spills could also occur. It is assumed that two large oil spills could occur during the entire life of oil development and oil production activities. One spill is a 5100 bbl spill from a platform located a minimum of 60 miles offshore; the second spill is a 1700 bbl spill from a pipeline at an unknown location.

Small Oil Spills. Section 4.1.2.5 and Tables 4-1 and 4-2 describe the assumptions about small oil spills. The effects of small spills on fish during open water would be the same as previously described in exploration and development. Years 10- 25, however, would potentially add 6 more small refined spills per year (3 bbl each). During Years 10-25, small refined oil spills, small crude oil spills, and small condensate spills, could occur at any time of the year. Two small crude oil spills (≥500 bbl and <1,000 bbl) could potentially occur. Of these two small crude oil spills, one is assumed to occur offshore, and one is assumed to occur from the 300 mi onshore pipeline.

The effects of small refined spills on fish are described under Years 1-5. A small crude oil spill or condensate spill at sea during open water would introduce hydrocarbon contaminants of various weights into the surface water, causing a temporary decrease in surface water quality and conditions for toxicity to fish life stages in the surface water. The effects on fish of a small crude oil spill or condensate spill would be similar to the effects of refined spills on fish in Years 1-5, however, the level of toxicity would differ among the three types of small spills.

During ice season, small crude oil spills and small condensate spills would introduce contaminants to sea ice and into surface waters if the spill occurred in broken ice. A small crude oil spill on ice or in broken ice would persist longer than a refined spill; a small condensate spill would persist for a shorter period than a refined spill.

A small crude spill from an onshore pipeline could enter freshwaters through a stream, pond system, or wetland, causing a diminishment of water quality and potential toxicity to sensitive life stages of fish. A small crude oil spill could persist in low velocity waters, such as a pond or small low-gradient stream, potentially causing conditions of toxicity for resident fish.

Large Oil Spills. Section 4.1.2.5 and Table 4-3 describe the assumptions for two large oil spills. The assessment of large oil-spill impacts are based on a combination of factors, including the oil type, spill size, spill duration and weathering, the paths (trajectories) the spill(s) follow, and the probability of one or more large spills occurring. Appendix A further describes the many facets of large oil-spill assessment. The weathering characteristics of the assumed 1,700 bbl pipeline spill and the 5,100-bbl OCS platform spill are shown in Table A.1-6 and 7, respectively.

Degradation of water quality potentially affects fish habitat, fish, and fish prey. Crude oil, condensate, and diesel spills could alter water chemistry as hydrocarbon compounds that are toxic to fish dissolve and accumulate in the water underlying the spill. Sensitive life stages of fish and fish prey, that are often weak swimmers or non-swimmers, would be exposed to concentrations that could cause acute effects, or chronic effects that extend beyond the time of the spill. In a large oil spill, concentrations of dissolved oil that move from the surface water into the upper water column could then spread horizontally in the water column, causing potentially acute and chronic effects on weak- and non-swimming fish and fish prey. Strong-swimming fish would potentially disperse to avoid a spill, however, avoidance can cause fish to abandon important feeding, reproductive, or sheltering areas.

Years 10-25: Effects of Large Oil Spill(s) (≥1,000 bbl) on Fish. Two large spill(s), large condensate spills, or large diesel spills could potentially occur during development. These spills could affect marine, coastal, tidal, riverine, and freshwater fish. The effects of large crude, condensate, or refined oils spills on marine, coastal, and tidal riverine fish are as follows:

- Large oil spill(s) would introduce hydrocarbons to marine, coastal, tidal riverine, and freshwater fish habitat causing degradation of aquatic habitat.
- Displacement from preferred habitat for feeding, reproduction, and sheltering due to habitat contamination.
- Impede access of migratory fishes to natal spawning habitat because of contaminated coastal waters or river mouths.
- Disruption of seasonal migratory movements to feeding areas and overwintering areas.
- Impaired homing abilities to return to natal waters.
- Constrain or eliminate prey populations normally available for consumption.
- Physiological stress including increased swimming activity.
- Organ and tissue contamination and associated physiological effects.
- Mortality of sensitive fish life stages (particularly eggs and larvae in surface water).
- Abnormal development and delayed growth due to acute or chronic exposures in spawning or nursery areas.
- Increase or introduction of genetic abnormalities within a fish species' gene pool.
- Reduction of fitness and survival of individuals, and increased susceptibility to predation, parasitism, disease, and environmental perturbations.

BOEM has updated the oil-spill analysis to reflect new ERA polygons (shape and size adjustments), reduction in number of launch areas (LAs), model refinements, and changes in the Scenario.

Conditional Probabilities

This section discusses the chance that a large oil spill(s) from the Leased Area could contact specific ERAs/GLSs/LSs that are important to fish, assuming a hypothetical large spill(s) occurs. The following discussion summarizes the results for all LAs and PLs within the Leased Area unless otherwise specified. The ERAs/GLSs/LSs used in this analysis for fish are shown in Appendix A, Table A.1-15 and Maps A.2a- A.2f, A.3a-A.3c. Maps A.4a-A.4c show the associated spatial locations.

Large Spills Summer

A large spill that occurred in the summer (Table 4-42) would have a ≥0.5 % chance, within 30 or 360 days, of contacting the following coastal resource areas important to fish:

- Two ERAs: Saffon cod essential fish habitat (EFH) and Opilio crab EFH, in the U.S. Chukchi Sea
- One GLS: Kuk River, along the U.S. Chukchi Sea Coast
- Seven LSs along the U.S. Chukchi Sea coast: Sulupoaktak Channel, Pitmegea River, Kuchiak Creek, Kukpowruk River, Kokolik River, Kugrua River, Utukok River-Kasegaluk Lagoon
- Three LSs along the Russia Chukchi Sea coast: Amguema River, Kolyuchinskaya Bay, Chegitun River

The percent chance of a summer spill contacting a coastal environment important to fish (either 30 or 360 days after the spill) ranges from 1% to 68%. EFH for saffron cod, as designated in the Arctic Fishery Management Plan (NPFMC, 2009), has the highest percent chance (up to 68%) of contact from a summer spill within both 30 and 360 days. Essential fish habitat for opilio crab in the Chukchi Sea has up to an 8% chance of being contacted by a large oil spill in summer.

Kuk River, designated as Anadromous Waters by the Alaska Department of Fish and Game (ADF&G), has up to an 8% chance of contact within either 30 or 360 days. Seven other U.S. rivers designated as Anadromous Waters by ADF&G would have a chance of contact up to 4%. Three anadromous rivers on the Russian Chukchi Sea coastline have a chance of contact up to 2% in a summer spill within both 30 and 360 days. The U.S. and Russian anadromous fish species potentially affected in these rivers are shown in Table 4-42.

Table 4-42. Fish–Summer Chance of Large Oil Spill Contacting within 30 and 360 Days.[1]

Resource Areas	Area Affected by any Value ≥0.5 %	Chance of Contact Summer 30 days:	Chance of Contact Summer 360 days:	Fish Species Affected
ERA	Saffron cod EFH ERA 103 Opilio Crab EFHERA 102	10 - 67% 1 – 8%	13 - 68% 1 – 8%	Saffron cod Opilio Crab
GLS	Kuk River GLS 151	1 – 8%	1 – 8%	Chum salmon, Pink salmon, Least cisco, Rainbow smelt, Broad whitefish; marine fish occurring nearshore
U.S. LS	Sulupoaktak Channel; Kuchiak Creek; and Pitmegea, Kukpowruk Kokolik, Kugrua Rivers; Utukok River-Kasegaluk Lagoon; U.S. Chukchi Sea Coastal Land Segments (LS): 64, 67, 70, 71, 72, 74, 80	1 – 4%	1 – 4%	Chum, Pink, and Coho salmon, spawning; Dolly Varden, spawning
Russia LS	Kolyuchinskaya Bay; Amguema and Chegitun Rivers Russia Chukchi Sea Coastal Land Segments (LS): 25, 31, 37	1%	1 – 2%	Chum, Pink, King, Sockeye and Coho salmon, spawning; Dolly Varden, Arctic char, spawning; whitefish, spawning; rainbow smelt; Bering cisco; Arctic lamprey

Note: Summer Conditional Probabilities (expressed as percent chance) that a Large Oil Spill from the Leased Area Starting at a Particular Location Will Contact a Certain Resource Area Important to Fish Within 30 days and Within 360 days from the Time of the Spill.

A large oil spill contacting anadromous river mouths can deter fish from entering to spawn or leaving the river after maturation. Anadromous species that spawn near river mouths can be affected by a large oil spill, causing chronic or acute effects, particularly on early life stages.

Large spills from Launch Areas during summer that would have the greatest percent chance of contacting important fish areas are: 10 and 11, and to a lesser degree, 4 and 5. Large spills from the two nearshore pipelines (pipeline (PL) segments 6 and 9, called PL 6 and PL 9, repectively) would affect most of the summer contact areas for fish listed in Table 4-42; a third nearshore pipeline (PL 3) would have effects on coastal fish resources, but on fewer areas than PL 6 and PL 9.

Based on the percent chance of contact from a summer spill and the areas contacted (within 30 and 360 days), the fish species most likely affected include: saffron cod, chum salmon, pink salmon, sockeye salmon, coho salmon, king salmon, Dolly Varden, Arctic char, whitefish, Arctic lamprey, rainbow smelt, Bering cisco, least cisco, opilio crab, and marine fish occurring near the shore and in tidal riverine environments.

Large Spills Winter

A large spill that occurred in the winter (Table 4-43) would have a ≥0.5 % chance, within 360 days, of contacting the following coastal resource areas important to fish:

- Two Environmental Resource Areas (ERAs): Saffon cod EFH and Opilio crab EFH, in the U.S. Chukchi Sea
- One Grouped Land Segment (GLS): Kuk River, along the U.S. Chukchi Sea coast
- Five Land Segments (LS) along the U.S. Chukchi Sea coast: Sulupoaktak Channel, Pitmegea River, Kokolik River, Kugrua River, Utukok River-Kasegaluk Lagoon
- Five LS along the Russia Chukchi Sea coast: Amguema River, Kolyuchinskaya Bay, Chegitun River, Inchoun Lagoon, Uelen Lagoon

The percent chance of a winter spill contacting a coastal environment important to fish 360 days after the spill ranges from 1% to 61%. The EFH for saffron cod, as designated in the Arctic Fishery Management Plan (NPFMC, 2009), has the highest percent chance of contact (61%) from a winter spill after 360 days. Essential fish habitat for opilio crab in the Chukchi Sea has up to a 16% chance of being contacted by a large oil spill in winter; this is double the percent chance of contact of opilio crab EFH in a summer spill.

Kuk River has a chance of contact up to 4% after 360 days in a winter spill; this is half the percent chance of contact for Kuk River in a summer spill. Five other U.S. rivers designated as Anadromous Waters would have a chance of contact up to 3%. Five anadromous rivers on the Russian Chukchi Sea coast have a percent chance of contact up to 5% in a winter spill after 360 days; this percent chance is more than double than the percent chance in a summer spill. The fish species potentially affected in these U.S. and Russian anadromous waters in a large winter spill are shown in Table 4-43.

Table 4-43. Fish–Winter Chance of Large Oil Spill Contacting within 360 Days.

Resource	Area Affected by any Value ≥0.5%	Range of Percent Chance ≥0.5: Winter-360 days	Fish Species Affected
ERA	Saffron cod EFH: ERA 103 Opilio Crab EFH: ERA 102	6 - 61% 2 - 16 %	Saffron cod, Opilio Crab
GLS	Kuk River: GLS 151	1 – 4%	Chum salmon, Pink salmon, Least cisco, Rainbow smelt, Broad whitefish; marine fish occurring nearshore
U.S. LS	Sulupoaktak Channel; Pitmegea, Kokolik, Kugrua Rivers; Utukok River-Kasegaluk Lagoon U.S. Coastal LS: 64, 67, 72, 74, 80	1 – 3%	Chum and Pink salmon, spawning; Dolly Varden
Russia LS	Amguema River, Kolyuchinskaya Bay, Chegitun River, Inchoun Lagoon, Uelen Lagoon Russia Coastal LS: 25, 31, 37, 38, 39	1 – 5%	Chum, Pink, King, Sockeye and Coho salmon, spawning; Dolly Varden, Arctic char, spawning; whitefish, spawning; rainbow smelt; Bering cisco; Least cisco; Arctic lamprey

Note: Winter Conditional Probabilities (expressed as percent chance) that a Large Oil Spill Starting at a Particular Location Will Contact a Certain Resource Area (RA) Important to Fish within 360 Days of a Large Winter Spill.

Large spills from LAs during winter that would have the highest percent chance of contacting important fish areas within 360 days are: LA 10, 11, and to a lesser degree, 8. Large winter spills from the two nearshore pipelines (PL 6 and PL 9) would affect most of the areas for fish within 360 days (Table 4-43); a third nearshore pipeline (PL 3) would have effects on coastal fish resources from a winter spill, but on fewer areas than PL 6 and PL 9.

Based on the percent chance of contact from a winter spill and the areas contacted (within 360 days), the fish species most likely affected include: saffron cod, chum salmon, pink salmon, sockeye salmon, coho salmon, king salmon, Dolly Varden, Arctic char, whitefish, rainbow smelt, Arctic lamprey, Bering cisco, least cisco, opilio crab, and marine fish occurring near the shore and in tidal riverine environments.

Combined Probabilities

Combined probabilities differ from conditional probabilities by incorporating the percent chance of one or more large spills occurring and contacting any portion of a particular resource. Tables 4-42 and 4-43 present areas of importance to anadromous and coastal fish (with percent chance of contact ≥0.5 %). For each of these resource areas, the table shows the estimated number of large spills occurring and contacting a resource area important to fish. The chance of one or more large spill occurring and contacting within 30 or 360 days, respectively is as follows:

- ERA 102 Opilio Crab EFH: 6-7%
- ERA 103 Safron Cod EFH: 37-40%
- LS 25, 31, 37-39: <0.5-1%
- LS 64, 72, 74, 80, 85: 1-4%
- GLS 151 Kuk River: 3-4%

The fish resource areas with the highest percent chance of large spills occurring and contacting are: saffron cod EFH, opilio crab EFH, and Kuk River on the U.S. Chukchi Sea coast. To a lesser degree, the Amguema River and Kolyuchinskaya Bay would be the most affected fish resource areas the Russian Chukchi Sea coast by the probability of large spills over the life of the Leased Area.

Spill Response

An oil-spill-response plan would be required prior to exploration or development and production activities. Oil-spill response could reduce the effects of an oil spill on fish through containment and cleanup. During oil-spill-response activities, fish could be affected by an increase in the number of vessels operating and the associated vessel discharges, and small refined spills associated with the response operations.

Fishes of concern that would be affected during Years 10-25 due to their distribution, abundance, trophic relationships, or vulnerability include: diadromous fishes that are abundant seasonally in the nearshore zone, especially arctic char, least cisco, and broad whitefish; Arctic cod eggs, larvae, and age-0; intertidal/estuarine/nearshore spawning and/or rearing fishes, particularly capelin, Pacific herring, and sand lance; and Pacific salmon in their marine and estuarine migration and staging periods of life.

Based on the criteria outlined in Section 4.2, the impacts on fish (considering all life stages of all fish species) from routine oil and gas activities would be minor. Although mortality of individuals would occur, and there could be potential introduction of invasive species, the effects on fish would be localized and short-term. In the event of a large oil spill, effects would be moderate because they would be widespread, long-lasting, mortality of individuals would occur, and there would be increased potential for introduction of invasive species. As stated above, the effects of climate change would be on-going in this and subsequent phases. While the magnitude of potential effects from the

Scenario on fish is not anticipated to change, climate change could affect species composition, number and distribution.

Development and Production (Years 26-50)

During Years 26-50, fish would be affected by development and production activities from noise, physical presence of vessel traffic, discharges, habitat alteration, water withdrawals, construction of platforms, construction of onshore and offshore pipelines, ice-management, small refined oil spills, large oil spill(s), and the potential risk of introducing aquatic invasive species. Fish in offshore, nearshore, coastal riverine and freshwater environments at all depths would be affected by these development and production activities in Years 26-50.

Noise from development and production sources would affect fish behavior over this 25-year period. Fish and fish habitat could also be affected negatively during Years 26-50 if an aquatic invasive species was introduced.

Onshore activities (habitat alteration, water withdrawals, noise, small fuel spills, discharges, and runoff) could affect freshwater fish and fish habitat (Arctic grayling, round whitefish, sheefish, lake trout, burbot, northern pike, Alaska blackfish, slimy sculpin).

Mortality of marine benthic fish would occur through injury or burial as a result of seafloor excavation, installation of platforms, construction and maintenance activities on the seafloor, and bottom water discharges (e.g. benthic-obligate life stages of flatfish species, sculpin species, eelpout species, prickleback species, snailfish species, sand lance, saffron cod). Mortality of marine surfacewater eggs, larvae, and juvenile fish would occur as a result of water withdrawals, surfacewater discharges, cavitation, vibrations, entrainment, and small refined oil spills (e.g. herring, capelin, Arctic cod, saffron cod, pink salmon, chum salmon, sand lance). The combined mortalities from these sources during Years 26-50 are not likely to affect the populations of the various fish species as they are currently understood in the Chukchi Sea.

Small refined and crude spills (<1,000 bbl) and large (≥1,000 bbl) crude, condensate, or diesel spills could occur during development and production. Two large spills are assumed to occur during the entire life of development and production. The effects of small refined spills are analyzed above under exploration in Years 1-5; large spill effects are analyzed under development (Years 10-25).

Section 4.1.2.5 describes the assumptions for a gas release(s). In the event of a natural gas release at sea, methane would be released into the water and proceed to rise through the water column as a function of depth of release (pressure), volume of release, rate of release, water temperature, and ice presence or absence. When released in a blowout or rupture at depth, the water quality would be altered temporarily. 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 higher concentration of CO_2 near the surface would affect chemical and biological processes and reactions at the water-air interface. A gas release from an onshore above-ground pipeline could potentially affect fish in ponds, streams, and wetlands, directly under the pipeline through percussive sound.

Fishes of particular concern that would be affected during Years 26-50 due to their distribution, abundance, trophic relationships, or vulnerability include: diadromous fishes that are abundant seasonally in the nearshore zone, especially arctic char, least cisco, and broad whitefish; Arctic cod eggs, larvae, and age-0; intertidal/estuarine/nearshore spawning and/or rearing fishes, particularly capelin, Pacific herring, and sand lance; and Pacific salmon in their marine and estuarine migration and staging periods of life.

Based on the criteria outlined in Section 4.2, the impacts on fish (considering all life stages of all fish species) from routine oil and gas activities would be minor. Although mortality of individuals would occur, and there could be potential introduction of invasive species, the effects on fish would be localized and short-term. In the event of a large oil spill, effects would be moderate because they would be widespread, long-lasting, mortality of individuals would occur, and there would be increased potential for introduction of invasive species. As stated above, the effects of climate change would be on-going in this and subsequent phases. While the magnitude of potential effects from the Scenario on fish is not anticipated to change, climate change could affect species composition, number and distribution.

Production and Decommissioning (Years 51-77)

During Years 51-77, fish would be affected by impact producing factors associated with production activities including noise, physical presence of vessel traffic, discharges, water withdrawals, ice-management, small refined oil spills, large oil spill(s), and the potential risk of introducing aquatic invasive species. Fish in offshore, nearshore, coastal riverine and freshwater environments at all depths would be affected by these development and production activities in Years 51-77.

Mortality of marine benthic fish (various life stages) would occur through injury or burial as a result of bottom water discharges. Mortality of marine surfacewater eggs, larvae, and age-0 fish would occur as a result of water withdrawals, cavitation, vibrations, entrainment, surfacewater discharges, and small refined oil spills. The combined mortalities from these sources during Years 51-77 are not likely to affect the populations of these various fish species.

Noise from production sources would affect fish behavior over this 26-year period. Fish and fish habitat could also be affected negatively during Years 26-50 if an aquatic invasive species was introduced and radiated quickly and broadly.

Onshore activities (habitat alteration, water withdrawals, noise, small fuel spills, discharges, and runoff) could affect freshwater fish and fish habitat (Arctic grayling, round whitefish, sheefish, lake trout, burbot, northern pike, Alaska blackfish, slimy sculpin).

Small (<1,000 bbl) and large (≥1,000 bbl) crude, condensate or diesel spills could occur until Year 53, when crude oil and natural gas liquid condensate production ends. Large diesel spills and gas releases could occur through Year 74. Refined small spills could occur through Year 77.

The effects of small refined spills on fish are described above under Years 1-5. The effects on fish of small crude spills, small condensate spills, and large oil spills, are described above under Years 10-25 and gas releases under Years 26-50.

Fishes of particular concern that would be affected during Years 51-77 due to their distribution, abundance, trophic relationships, or vulnerability include: diadromous fishes that are abundant seasonally in the nearshore zone, especially arctic char, least cisco, and broad whitefish; Arctic cod eggs, larvae, and age-0; intertidal/estuarine/nearshore spawning and/or rearing fishes, particularly capelin, Pacific herring, and sand lance; and Pacific salmon in their marine and estuarine migration and staging periods of life.

Based on the criteria outlined in Section 4.2, the impacts on fish (considering all life stages of all fish species) from routine oil and gas activities during this phase would be minor. Although mortality of individuals would occur, and there could be potential introduction of invasive species, the effects on fish would be localized and short-term. In the event of a large oil spill, effects would be moderate because they would be widespread, long-lasting, mortality of individuals would occur, and there would be increased potential for introduction of invasive species.

Conclusion

Considering all time periods (Years 1-77, presented above) and all types of effects from the activities during these time periods (including two large oil spills between Years 10-74), the impacts on fish from routine oil and gas activities from the Scenario would be minor. Although mortality of individuals would occur, and there could be potential introduction of invasive species, the effects on fish would be localized and short-term. In the event of a large oil spill, effects would be moderate because they would be widespread, long-lasting, mortality of individuals would occur, and there would be potential for introduction of invasive species. As stated above, the effects of climate change would be on-going throughout the time fram of the Scenario. While the magnitude of potential effects from the Scenario on fish is not anticipated to change, climate change could affect species composition, number and distribution.

Mitigation Measures

The effects of the Scenario on fish may be modified by application of mitigation measures. Measures outlined in Lease Stipulations (Appendix D) and Information to Lessee No. 3 – River Deltas; and No. 8 – Sensitive Areas to be Considered in the Oil-Spill Response Plans, at www.boem.gov/ak193 provide for future protective measures to be developed that protect unique biological communities. Also, ramp up procedures that would likely be used as a mitigation measures to avoid/minimize impacts to marine mammals would also benefit fish. In addition, the effects of small spills to all resoruces would be limited by requirements such as spill-catchment equipment on vessels, MODUs, and at land facilities; deployment of booming equipment during OCS fuel transfers; and automatic shutdown of fuel lines triggered by decreased pressure.

4.3.5.2. Alternative II – No Action

If Lease Sale 193 were not affirmed, fish species (various life stages) would not be affected by potential small and large oil spills, discharges, and water withdrawals associated with the Leased Area exploration, development, production, and decommissioning activities. There would also be less freshwater, estuarine, and marine fish habitat disturbance. Underwater noise would be reduced in the soundscape by the potential noise associated with Leased Area exploration, development, production, and decommissioning. The possibility of introducing aquatic invasive species from Leased Area activities would be eliminated.

4.3.5.3. Alternative III – Corridor I Deferral

Alternative III provides the largest deferral area of the action alternatives – a corridor approximately 60 miles (97 km) wide along the Chukchi Sea shoreline. If Alternative III were selected, the distance from the shore to many activities could be greater than under Alternatives I and IV. No exploration or development drilling or platform construction would occur within the corridor, although certain activities (i.e., installation of a pipeline extending from the leases outside the corridor to the shore) could occur there. Of the Lease Sale 193 leases, only five are within Corridor I.

The minimum distance from shore under Alternative III could be slightly greater for the following than under the other action alternatives: length of pipeline from a platform to shore; travel distances from vessels and aircraft; source of discharges, emissions and noise from drilling and platforms; and, potentially the source of a large OCS oil spill.

Slightly greater adverse impacts to fish resources from routine activities would occur under Alternative III than under the other action alternatives due to more trenching, longer excavation times, greater seafloor disturbance, more vessel noise; and longer water/sediment suspension times. Because many activities could not occur in the corridor, however, some localized impacts to fish, such as localized discharges and drilling noise, would be prevented under this alternative. A primary benefit to fish of a wider corridor is that it could slightly reduce the likelihood of accidental spills and gas releases contacting nearshore areas, increase weathering of spilled oil, and increase available spill response time. The effects of Alternative III using the Impacts Scale in Section 4.2 would consistent with the other action alternatives.

4.3.6. Marine and Coastal Birds

The 2007 FEIS and 2011 SEIS analyzed Threatened and Endangered birds in one section, and other Marine and Coastal birds in a separate section. For this Second SEIS, the following Marine and Coastal Birds section includes a separate analysis of Threatened and Endangered bird species within the larger resource group, but not as a separate section.

4.3.6.1. Alternatives I and IV

Impact Producing Factors

This section identifies the Impact Producing Factors (IPFs) resulting from the oil and gas activities associated with the Scenario. It discusses the manner in which each identified IPF can affect various species or species groups of marine and coastal birds, including threatened and endangered birds (Steller's eiders and spectacled eiders, both threatened). These are sometimes referred to as ESA-listed birds. IPFs are organized by phase of oil and gas activity (i.e. exploration, development, production, and decommissioning). IPFs which occur during multiple phases are addressed in the phase in which they first appear; these discussions are then referenced where applicable.

Previous analyses have identified an increase in predator populations and increased hunter access to be impact producing factors. Predators of concern, including ravens and foxes, have proven difficult to control/manage despite intensive industry effort. Their impacts are difficult to document (Liebezeit et al., 2009). Also, increased efforts towards hunter education may reduce the potential effects of expanded hunter access and misidentification of listed eiders (79 *FR* 53119, September 5, 2014). These two IPFs are not addressed further.

Accidental spills, though not considered routine oil and gas activities, have the potential to occur during each phase. General impacts of small and large spills are addressed as IPFs in the subsection where they have the potential to occur. The impacts of spills within the larger context of all other activities that occur during each period are analyzed in the subsection below, "Impacts of the Scenario Through Time."

Exploration

The activities associated with the exploration phase include vessel-based surveys and drilling activities. These activities use aircraft and variously sized vessels (including MODUs). In this phase, limited construction of land-based facilities would also begin. The IPFs associated with the Exploraiton phase include: Noise, Physical Presence, Discharges, Habitat Alteration, and Accidental Oil Spills.

Noise

The potential impacts from noise on marine and coastal birds were described in the 2007 FEIS (Section IV.C.1.f(2) (page IV-125)) and the USFWS 2012 Biological Opinion (USFWS, 2012) and are summarized below. Several groups of marine and coastal bird species, including eiders and loons, forage in the water column and seafloor and could be exposed to underwater noise. Underwater noise could be generated by vessels, seismic and geohazard surveys, and drilling operations. Birds could also react to the airborne sounds of planes and helicopters. Noise has the potential to displace birds from important locations such as foraging areas. Also, there is an energetic cost to repeatedly moving away from disturbances as well as a cost in terms of lost foraging opportunities or displacement to an area of lower prey availability.

Noise from Vessels. Most birds move away from slow-moving vessels by paddling away with their feet or taking flight. Flightless birds at sea remain capable of slowly moving away from vessels. Birds on the water surface may dive upon approach by faster vessels.

Noise from Marine Seismic and Geohazard Surveys. These surveys generate intense energy pulses in the water column. It is conceivable that a bird could be near enough to a marine seismic or geohazard survey sound source to be injured. The reactions of birds to underwater noise suggest that a bird would have to be very close to the marine seismic or geohazard survey sound source to receive an energy pulse strong enough to cause injury, if that were possible at all. Injury to birds is not expected because birds are most likely to move away from slow-moving survey vessels well in advance of the marine seismic or geohazard survey sound source.

Noise from Exploration Drilling. Drilling operations can emit sound– underwater or above water – that could disturb birds. Underwater noise in particular could injure a bird if it was very close to the drill rig. Marine and coastal birds, however, are most likely to move away from or not approach drilling operations if the sound disturbed them.

Noise from Aircraft. 2007 FEIS (Section IV.C.1.g(2)(a)3 (page IV-127)) and the USFWS 2012 Biological Opinion (page 73) described the types of effects aircraft could have on marine and coastal birds/threatened and endangered birds. While most marine and coastal birds are well aware of aircraft and react/move away before the aircraft noise can harm them, some species like staging brant and molting ducks could be impacted (Ward and Stehn 1989, Ward et al. 1994; 1999).

Physical Presence

The physical presence of vessels, aircraft, and field crews could impact marine and coastal birds including listed species. Birds normally move away from these activities but could be displaced from important locations such as foraging areas or nests. Also, there is an energetic cost to repeatedly moving away from disturbances as well as a cost in terms of lost foraging opportunities or displacement to an area of lower prey availability. Disturbance at nest sites could decrease nest productivity due to abandonment or predation. Structures could also present a hazard to flying birds.

Vessels. The potential effects of vessels on marine and coastal birds were described in the 2007 FEIS (Section IV.C.1.f(2), (page IV-125)) and BOEM's 2011 Biological Assessment (USDOI, BOEM, 2015a, pp. 71-72). Vessel activity could disturb birds; flocks of migrating or flightless birds would generally move away from vessel activity.

Vessels in the marine environment can become obstacles to flying birds. Birds attracted to lights and vessels could collide with a vessel and be injured or killed. Flying birds, particularly during migration, could be disoriented by storms or collide with vessels during inclement weather (e.g., fog, rain) or darkness. Vessels operating in marine environments often encounter birds when they are migrating. These potential effects were described in 2007 FEIS (Section IV.C.1.g(2)(b) (page 128)) and the 2012 USFWS Biological Opinion.

The 2011 SEIS described bird encounters with vessels to be a rare event (page 113); however, BOEM has required monitoring of bird encounters during certain OCS activities and new information is available. In 2012, a lessee conducting an exploration drilling program in the Chukchi and Beaufort Seas reported that at least 131 birds were observed on their MODUs and support vessels, 83 (63%) of which were dead (Shell, Offshore, Inc., 2013, unpublished data). In some cases, it appeared that some birds sought refuge on a vessel in inclement weather and rested on the vessel until continuing migration. In other cases, exhausted birds appeared to have alighted on a vessel, but did not survive. The injuries and mortalities, however, strongly indicated birds collided with vessel structures and died or later succumbed to injuries. Industry reported 18 bird:vessel encounters during the 2013 open-water season, with only a few vessels in operation.

BOEM calculated bird encounter rates based on the encounter reports from a 2012 exploration drilling program. These rates may underestimate impacts in that some birds 1) could have struck a vessel but landed overboard and been lost at sea undetected, or 2) alighted, rested, and departed undetected. Not all encounters are fatal and, in some cases, crew assistance likely helped some birds survive. The rates are not an index, but simply an estimate of the number of birds encountering vessels during one open-water operational period (season).). Note that this estimate of bird encounter rates could be higher if strucutres (e.g., MODUs, vessels or platforms) are located in areas that are known to have high densities of birds, such as Hanna Shoal or areas near Barrow Canyon. BOEM estimated that birds would encounter drillships at a greater rate (53 birds per season) than smaller support vessels (11 birds per season). For the purposes of this analysis, BOEM overestimated the level of impact by assuming that all marine and coastal birds making contact with vessels are mortalities.

Aircraft. The potential effects of aircraft (airplanes and helicopters) on marine and coastal birds were described in the 2007 FEIS (Section IV.C.1.g(2)(a)3 (page IV-126)) and BOEM's 2015 Biological Assessment (USDOI, BOEM, 2015b, pp. 70-71). Individual nests may be disturbed repeatedly by low-flying aircraft, especially helicopters. When disturbed, the female tends to flush from the nest. These nests may be abandoned and the eggs or young could die or be eaten by predators. Also some species, like staging brant and molting sea ducks, could be impacted (Ward and Stehn, 1989, Ward et al. 1994 and 1999) if they are repeatedly disturbed during foraging.

Field crews. Field crews could conduct land-based operations during the nesting season and field crews could disturb nesting birds. Although no land or on-ice surveys are anticipated by the Scenario, the potential effects of onshore activity associated with an on-ice survey, recently described in the SAExploration EA (USDOI, BOEM, 2014b, page 45), include the possibility that individual nests may be disturbed repeatedly by field crew activity. When disturbed, the female tends to flush from the nest. These nests may be abandoned and the eggs or young could die or be eaten by predators.

Discharges

Discharge of Muds and Cuttings. Exploratory drilling could directly affect a very small area of benthic habitat with increased turbidity and discharge of drilling muds and cuttings. These discharges could make it more difficult for foraging birds to locate foods, especially benthic prey. The 2007 FEIS (Section IV.C.1.g(4)(b) (page IV-137)) and the BOEMRE 2015 Biological Assessment (USDOI, BOEM, 2015b, pp. 75-76) described how discharges may result in contamination of marine habitats. Such contamination may impact individual birds either through direct contact or indirectly as a result of effects on prey populations or important habitats. The EPA regulates the discharge of drilling muds (used to lubricate drill bits), cuttings (material removed from drill holes), and other materials to the marine environment. The Chuckchi Sea exploration NPDES general permit (AKG-28-8100) for oil and gas exploration facilities on the OCS is currently effective, and discharges of materials to the marine environment are expected to meet current standards.

Discharge of Graywater and Ballast Water. Vessel or platform operations could include the discharge of graywater and ballast water into the marine environment. The Chukchi Sea exploration NPDES general permit (AKG-28-8100) authorizes discharges from oil and gas exploration facilities. The EPA regulations at 40 CFR 125.122 require a determination that the permitted discharge will not cause unreasonable degradation to the marine environment.

Habitat Alteration

Activities associated with the exploration phase that would potentially affect habitat (primarily wetland habitat as described in Section 4.3.9) include construction of camps for shore-based facilities, roads to access various project facilities; and expansion of existing material sources or development of new material sources. The amount of direct habitat loss includes the size of the facility footprint, as well as associated sites such as gravel pits and transportation/access routes. Indirect habitat loss and/or dedragation could occur adjacent to filled areas via dust accumulation and hydrological alteration that could alter plant communities. These activities can directly and/or indirectly affect marine and coastal birds by filling or excavating nesting, resting, or foraging habitat; converting existing vegetated communities to different communities or to open water habitat; and/or disturbing/displacing birds from areas around facilities.

Accidental Oil Spills

The impacts to birds from oil spills may include fouling of feathers, ingestion, skin irritation, etc. The potential effects were described in the 2007 FEIS (Section IV.C.1.g(2)(c), page IV-128 and Section IV.C.1.g(3), page IV-129) and the 2012 Biological Opinion (USFWS, 2012, page 77)). They range from acute exposure where a bird may be covered by a lethal amount of oil, to chronic exposure where a bird may be exposed to smaller amounts of oil over a longer period of time. Direct oiling would likely result in loss of feather insulation and acute or chronic toxicity from ingestion and absorption. Oiled birds could also carry oil to nests where eggs and young could be oiled. All birds contacted by spilled fuel are assumed to die.

Small Oil Spills. Small refined spills (<1,000 bbl, diesel) have the potential to occur during this exploration period. Should a fuel spill occur during refueling and escape containment, a small number of birds in the immediate vicinity of the vessel could be affected, depending on current and wind patterns. Few birds, however, are likely to be in the area during refueling and in the unlikely occurrence of a fuel spill, a limited number of individual bird mortalities could occur. Spill prevention and response measures would minimize effects to marine and coastal bird populations. Small spills are generally into containment, cleaned up immediately, and therefore do not reach the environment where they could contact marine and coastal birds.

Conclusion. Exploration typically involves activities/IPFs that have little direct or indirect impact to marine and coastal birds, including ESA-listed species. Marine and coastal birds generally move away from localized sources of disturbance and those sources of disturbance are not anticipated to occur in areas especially important to marine and coastal birds (e.g., Ledyard Bay Critical Habitat Unit (LBCHU) and the spring lead system). Few birds would be repeatedly exposed to disturbances. These short-term, localized effects do not persist across seasons. The greatest potential for direct effect comes from the physical presence of vessels in the marine environment; birds striking vessels could be killed. It is possible for the more abundant seabird (e.g., shearwaters, auklets) or seaduck (e.g., king eider, common eider) species to experience fewer than 50 strikes, which would be considered a minor impact. Overall, the activities conducted during this time period are anticipated to have a minor impact on marine and coastal birds including listed species, because they would be short-term, localized, and less than severe.

Development

Development is the construction of facilities to produce hydrocarbons and move them to market. Construction activities use aircraft and variously sized vessels to install facilities. The impacts associated with development activities include: Noise, Physical Presence, Discharges, Habitat Alteration, and Accidental Oil Spills. Many of the same IPFs that could arise from development activities were described for the exploration phase and those potential impacts are not repeated here. Only new activities associated with the IPFs are described below.

Noise

The installation of platforms and pipelines is the only new activity generating noise for this phase. The potential effect of noise from drilling wells for oil and gas production would be similar to that previously described for drilling exploration wells.

Physical Presence

The installation of platforms and pipelines would increase the number of vessels/barges operating in the marine environment, especially the nearshore environment. These vessels would be anticipated to have similar effects as regular support vessels, but the presence of cranes or larger superstructures could increase the bird encounter rate. Until and unless monitoring indicates otherwise, the bird encounter rates associated with construction vessels and barges are assumed to be the same as those for support vessels (11 bird:vessel encounters per season). Five vessels (one dredge, two supply barges, and two support vessels) are estimated to be involved in this activity each year there is offshore pipeline or facility construction.

Discharges

The installation of platforms and pipelines would increase the number of vessels/barges operating in the marine environment. Discharges of graywater and ballast water from these vessels would remain regulated by the same EPA NPDES permit structure as previously described under the exploration phase and effects to marine and coastal birds, including listed species, are not anticipated.

Habitat Alteration

The installation of platforms and pipelines would increase the amount of habitat disturbance or modification in the marine and terrestrial environments. Installation of undersea pipelines likely would involve trenching/seafloor excavation which could not only disturb/degrade seafloor habitats, but could suspend fine materials in the water column. These potential effects would be similar to those described for exploration drilling, but the affected sites would be larger and the effects would be distributed across a more extensive area.

Installation of pipelines across the terrestrial environment could permanently affect habitats where the pipelines are located. The amount of direct habitat loss is the size of the facility footprint, but also includes associated sites, such as gravel pits and transportation/access routes. Construction activities can also indirectly affect marine and coastal birds by displacing them from foraging or nesting areas around the facility. Additional discussion of direct and indirect impacts from habitat alteration/degradation is found in Section 4.3.9, Vegetation and Wetlands.

The total potential effect of construction activities on land can be estimated for some species. For example, the footprints of production facilities for the Chukchi Sea developments were estimated to affect several km^2 of eider nesting habitat (USDOI, BOEM, 2015b, pp.102-103).

Accidental Oil Spills

The potential effects on marine and coastal birds from large oil spills were analyzed in the 2007 FEIS (Section IV.C.1.g(3-6). They range from acute exposure where a bird may be covered by a lethal amount of oil, to chronic exposure where a bird may be exposed to smaller amounts of oil over a longer period of time. Effects of chronic exposure can range from lethal to sub-lethal. Common routes of exposure to oil include covering skin or feathers, inhalation of vapors, and ingesting oil or contaminated prey. These routes of exposure can lead to reproductive effects, reduced food sources, and displacement from feeding or molting sources. The 2007 FEIS analysis concluded that 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. All birds contacted by spilled fuel or crude oil are assumed to die.

Small or large refined spills are possible during production activities. Small and large crude spills are also possible until Year 53 when production of crude oil tapers off. Effects of small spills remain as described under Exploration above.

Large Oil Spills. Development activities carry the additional risk of large (≥1,000 bbl) refined or crude oil spills. Kasegaluk Lagoon, Peard Bay, colonies at Cape Thompson and Cape Lisburne, the open-water Spring-Lead System, Ledyard Bay, and barrier islands provide important nesting, molting, and migration habitat to a variety of waterfowl, shorebirds, and seabirds. Spills during periods of peak use could affect large numbers of birds. A large spill could impact, for example, large numbers of murres, puffins, and kittiwakes at the Cape Lisburne and Cape Thompson colonies. The magnitude of potential mortality could result in significant impacts to the colonies. In another typical example, up to 45% of the estimated Pacific Flyway population of Pacific brant could be affected if an oil spill reaches Kasegaluk Lagoon during fall migration. 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, especially for the small “Western High-Arctic” subpopulation of brant (Pacific Flyway Council, 2002). The situation with brant is similar to a wide variety of waterfowl and shorebirds that use similar areas of the Chukchi Sea, and these birds could experience lethal and sublethal effects that could ultimately result in polulaiton-level effects. Large-scale mortality could also occur to pelagic distributions of auklets and shearwaters during the open-water period, and to male and juvenile murres in the late summer.

Impacts to marine and coastal birds from large oil spills are further analyzed in 2007 FEIS (Section IV.C.1.g(3)(g) (pages IV-132 – 141). That analysis concluded that a large oil spill could affect nearshore areas used by nonbreeding loons or, later in the open-water season, loon broods. Depending on the spill timing and trajectory, and the locations of offshore loons, a large proportion of any sex-age class could experience extensive mortality. Extensive mortality of certain sex-age classes could contribute to immediate or gradual population-level impacts, including the large-scale loss of the yellow-billed and other loons on the North Slope.

The analysis for a large spill affecting ESA-listed birds was updated in the BOEM 2015 Biological Assessment (USDOI, BOEM, 2015b, p. 105). That analysis concluded that a large oil spill contacting the Ledyard Bay Critical Habitat Unit (LBCHU) during the open-water period could contact as many as 33,000 spectacled eiders, including the entire cohort of successfully breeding females and their young, using the Ledyard Bay molting area at one time. The loss of all or part of the breeding female spectacled eiders of the Arctic Coastal Plain would be anticipated to result in large-scale population-level effects. A similar impact could be experienced by Steller’s eiders using the spring lead system for staging prior to moving to the breeding grounds. A large spill contacting the spring lead system could affect a relatively large proportion of the Steller’s eider population. This would be considered a large-scale population-level effect on this species.

Production

Activities associated with production include vessel, aircraft, and vehicle traffic to operate/maintain facilities to produce hydrocarbons and move them to market. The impacts associated with the production phase include: Noise, Physical Presence, Habitat Alteration, and Accidental Oil Spills. Many of the same IPFs that could arise from production activities were described for the exploration and development phases and those potential impacts are not repeated here. Only new activities associated with the IPFs are described below.

Noise

There are no new sources of noise associated with the production phase.

Physical Presence

The presence of platforms and other facilities would have an ongoing effect on marine and coastal birds. Once the platform is installed in the offshore environment it remains an obstruction to marine and coastal birds as long as it remains. Until such time as monitoring data indicates otherwise, the bird encounter rate is assumed to be the same as for a exploration drilling rig (53 bird:vessel encounters per season). The fleet of support vessels normally associated with an exploration drilling vessel is not anticipated to be needed or would be substantially reduced.

Habitat Alteration

Activities on areas adjacent to facilities (e.g., shorebase, pipelines, and access roads) would have an ongoing effect of displacing birds from foraging and nesting sites. Degradation of habitats adjacent to the existing project footprint may also have ongoing impacts on birds.

Accidental Oil Spills

Small or large refined spills are possible during production activities. Small and large crude spills are also possible until Year 53 when production of crude oil tapers off. These effects of small spills and large spills remain as previously described above.

Impacts of the Scenario through Time

This section provides analysis of impacts to marine and coastal birds as they occur through the 77 years of the Scenario. This analysis addresses the particular oil and gas activities that could occur during each relevant time period and analyzes their impacts against the backdrop of a dynamic affected environment. Whereas previous sections have focused on identifying relevant IPFs and the types of environmental impacts they may cause, this section more specifically accounts for the level at which each IPF occurs during a given phase, the overlap of IPFs, and any additive or synergistic impacts which may result.

Impacts to marine and coastal birds are described in terms of a relative impact along a continuum or scale (Section 4.2). Impacts that are localized are less than those that are widespread. Impacts that are temporary are less than those that last for a season or decades. Activities than can result in mortalities can affect few individuals of the population (less than severe) or can affect so many that the population can take many years to recover (severe). Those activities that have effects that are localized, temporary, or have no detectable or low anticipated mortality (less than severe) would fall on the negligible end of the relative impact scale. At the other end of the relative impact scale, those activities that have effects that are wide-spread, long-term (decades), and would result in anticipated mortality that would not be recovered for an extended period were considered to result in major impacts. In total, these sections tell the story of how the activities comprising the Scenario could affect marine and coastal birds through time.

The following analyses consider the effects of ongoing climate change, and how the IPFs of the Scenario could affect marine and coastal birds in a shifting baseline. Bird numbers and distributions would likely shift over time in response to changes in areas used for foraging, breeding, molting and overwintering. Some bird species could benefit from creation of new habitats, or changes in prey distribution and abundance. Other species could be adversely affected by climate change. None of the IPFs addressed below should have appreciable direct interactions with climate change effects.

Exploration (Years 1-5)

During Years 1-5, the only activities anticipated include marine seismic surveys, geohazard and geotechnical surveys, and exploration drilling operations.

During this timeframe, no more than one marine seismic survey would occur (Year 1). Marine seismic surveys could involve as many as three vessels during the open-water season. Surveys conducted during other time periods would occur when birds are generally absent. The estimated level of impacts from each seismic survey would be 33 bird:vessel encounters each open-water season.

High-resolution (Geohazard and Geotechnical) surveys are typically conducted in association with exploration drilling, but in the absence of such drilling, could be conducted independently; three vessels are anticipated to be used for these surveys. There would be a degree of avoidance by marine and coastal birds around these vessels due to noise and physical presence; however, these effects are localized and the activities would not be conducted in areas of critical importance to birds (e.g., LBCHU or the spring lead system). The discharge of graywater and ballast water could have localized effects, but these effects would be associated with vessels and marine and coastal birds typically avoid operating vessels.

A marine seismic survey operation in the Chukchi Sea was analyzed in the 2013 TGS Geological and Geophysical EA (USDOI, BOEM, 2013a), and the 2014 SAE Geological and Geophysical EA (USDOI, BOEM, 2014b). For those activities, anticipated impacts included noise, disturbance, and a small fuel spill.

A geohazard/geotechnical survey was analyzed in 2013. Anticipated impacts included noise, vessel presence, and small fuel spill. During 2012 and 2013, operators conducted shallow hazard surveys in the nearshore Beaufort Sea and did not report any bird:vessel encounters.

Exploration drilling would also occur during Years 3-5 of this period. An exploration drilling operation in the Chukchi Sea was analyzed in 2012 EA. Anticipated impacts included vessel, MODU, and aircraft noise, physical presence, and discharges. Similar impacts are expected to result from the same activities analyzed here, but with two MODUs, not one. Drilling noise, aircraft noise, vessel noise, authorized discharges (muds, cuttings, graywater) and a possible small refined fuel spill are anticipated to have a negligible effect on marine and coastal birds, including listed species.

Impacts from birds encountering vessels were higher than anticipated during recent operations in the Chukchi Sea. Bird encounter reports were used to calculate the rate at which birds are now anticipated to encounter vessels in the Chukchi Sea. For drilling operations during the 2012 season, 414 bird:vessel encounters are estimated to have occured based on two independent drilling operations (1 drilling vessel (53 encounters) and 14 support vessels (154 encounters) per operation during a full season). These encounters would be distributed (percent, total for group) across seabirds (tubenoses, alcids, others) (21%, 87), seaducks (27%, 112), shorebirds (8%, 33), and passerines (44%, 182). The species distribution of the encounters within any group is diverse. It is possible for the more abundant seabird (e.g., shearwaters, auklets) or seaduck (e.g., king eider, common eider) species to experience encounters in the hundreds, which would be considered a moderate impact.

A small percentage of the 112 seaducks could include threatened and endangered species. Because listed eiders have not been reported to physically interact with vessels in the Chukchi Sea, it is assumed to be low. The USFWS issued an incidental take statement for 1 Steller’s eider and 13 spectacled eiders for BOEM’s Proposed Action described in the Biological Opinion (USFWS, 2012) covering a 14-year exploration period and activities in both the Chukchi and Beaufort Seas combined.

Small refined spills (<1,000 bbl) could occur during exploration activities but have little potential to affect marine and coastal birds for reasons described above. The analysis is for the leased area and vicinity, which includes Kotzebue Sound as part of the Chukchi Sea. Kotzebue Sound is used by fewer numbers of marine and coastal birds compared to the Chukchi Sea. Should a fuel spill of the magnitude defined in Section 4.1.2.5 and Tables 4-1 and 4-2 occur and escape containment, a small number of birds in the immediate vicinity of the vessel could be affected, depending on current and wind patterns. Few birds are likely to be in the area during refueling. In the unlikely occurrence of a fuel spill, there is some potential for a limited amount of individual bird mortality (and all birds contacted by spilled fuel are assumed to die), which could result in minor impacts; however, it is most likely that spill prevention and response measures would minimize effects to marine and coastal bird populations.

Conclusion. This time period typically involves activities/IPFs that have little direct impact to marine and coastal birds, including listed species. Marine and coastal birds generally move away from localized sources of disturbance and those sources of disturbance are not anticipated to occur in areas especially important to listed species. Few birds would be repeatedly exposed to disturbances. These short-term, localized effects do not persist across seasons. The greatest potential for direct effect comes from the physical presence of vessels in the marine environment; birds striking vessels could be killed. The assumed seaduck mortality associated with all marine and coastal birds encountering vessels during seismic survey (33 encounters) and exploration drilling (414 encounters) activities during this time period is estimated to be 121 seaducks (27% of total). Listed eiders would be a smaller subset of this total and this relatively low mortality rate would not impact any one species to a population-level effect. Should any population decline, the potential impact to that species could increase. It is anticipated that the more abundant seabird (e.g., shearwaters, auklets) or seaduck (e.g., king eider, common eider) species could experience up to 50 strikes, which would be considered a minor impact. The activities conducted during this time period are anticipated to be localized, short-term and have less than severe impacts. Consequently, impacts would be minor on marine and coastal birds, including ESA-listed species. As stated above, the effects of climate change would be on-going. The magnitude of potential effects from the Scenario on marine ande coastal birds is not anticipated to change, but climate change could affect species composition, number and distribution.

Exploration and Development (Years 6-9)

Exploration activities during this period would continue in roughly the same manner and frequency as during the preceding period, with impacts as predicted above. This period also includes offshore pipeline construction during each open-water period.

Construction of an offshore pipeline could affect marine and coastal birds. Impacts from offshore pipeline construction are analyzed for listed species in the Biological Opinion (USFWS, 2012, page 88), and are relevant for all species. Potential impacts included increased seafloor disturbance and suspended sediment. These activities would not be conducted in areas of critical importance to threatened and endangered birds (i.e., LBCHU or the spring lead system) and IPFs would be concentrated around construction sites. The physical presence of vessels in the offshore environment could present obstacles to marine and coastal birds. The five vessels anticipated to be used for offshore pipeline construction could result in 55 marine and coastal bird encounters per season.

Construction of the onshore pipeline would occur during the winter. Winter construction of an onshore pipeline would not have direct effects to threatened and endangered marine and coastal birds because they would not be in the area during the winter. There would be a lasting impact, however, from onshore pipeline construction in the direct loss of nesting habitat for some Arctic species, although nesting areas for most of these species are dispersed across the Arctic Coastal Plain or are outside the construction area. Listed spectacled eiders may be affected. Impacts to Steller's eider nesting habitats are not anticipated because they nest in a relatively small area around Barrow, which is not anticipated to be impacted by the pipeline corridor. While there remains uncertainty about the location(s) of onshore development, protections, including avoidance and other forms of mitigation, of the important habitat in the Barrow vicinity are expected from the multi-tiered decision making and review process in place for exploration and onshore development planning.

Additionally, vehicle and helicopter activity concentrated along the onshore pipeline route during the summer season could disturb/displace marine and coastal birds up to 200 meters from the pipeline/access road, causing an indirect effect.

The distribution of effects across species and species groups is such that no species would experience more than 50 mortalities. Several seaduck populations have experienced periodic declines (e.g., king eider, common eider) and the potential impact to those species could increase. In a declining population, losses are not recovered by recruitment.

The assumed seaduck mortality associated with all marine and coastal birds encountering all vessels during this period is estimated to be 65 seaducks (27% of total). Listed eiders would be a smaller subset of this total and this relatively low mortality rate would not impact any one species to a population-level effect. Steller's eiders and spectacled eiders have stable populations, so the degree of loss would be recovered during the subsequent breeding cycle. Should any population decline, the potential impact to that species could increase.

Conclusion. This time period involves the same activities as the exploration phase, but impacts increase due to offshore and onshore pipeline construction. Onshore pipeline construction has a direct impact on nesting habitat and effects from disturbance/displacement from areas around the pipeline facility. Pipeline construction activities are not anticipated to occur in areas especially important to marine and coastal birds or listed species. Few birds would be repeatedly exposed to disturbances. The permanent loss of habitat and displacement from habitats would persist across seasons. New direct effects include the physical presence of pipeline construction vessels in the marine environment and birds striking these vessels (55 birds) could be killed. Including 414 strikes for drilling operations and 33 resulting from seismic surveys, maximum estimated mortality per season during this period would be 502 birds. Overall, the activities conducted during this time period are anticipated to have a moderate impact on marine and coastal birds, including listed birds, because the effects are long-lasting and widespread, but less than severe. As stated above, the effects of climate change would be on-going. While the magnitude of potential effects from the Scenario on marine and coastal birds is not anticipated to change, climate change affects species composition, number and distribution.

Exploration, Development, and Production (Years 10-25)

This time period includes the same aspects of exploration and development as analyzed in previous sections above. Exploration drilling continues, and four marine seismic surveys during this period and impacts from that activity are considered. There is a small amount of periodic construction activity associated with platform installation. Meanwhile, production activities commence, to include the operation of offshore platforms and associated pipelines.

New direct effects include the physical presence of platforms in the marine environment and birds striking these platforms (53 per season per platform) could be killed. The level of bird loss estimated for Years 6-9 (502 birds per season) would continue, such that maximum estimated mortality per season during this period would be 1,091 birds (by Year 22).

The assumed mortality associated with all marine and coastal birds encountering all vessels and up to four drilling rigs/platforms during this period is estimated to involve 214 seabirds, 295 seaducks, 87 shorebirds, and 448 passerines. The distribution of these effects across species and species groups is such that several seaduck or seabird species would experience more than 100 mortalities, a major impact. Several seaduck populations have experienced periodic declines (e.g., king eider, common eider) and the potential impact to those species could increase. In a declining population, losses are not recovered by recruitment. Overall, the activities conducted during this time period are anticipated to have a clear, long-lasting change in the resource's function in the ecosystem, and thus this would be considered a major impact on marine and coastal birds.

The assumed seaduck mortality associated with all marine and coastal birds encountering all vessels during this period is estimated to be 295 seaducks (27% of total). Listed eiders would be a smaller subset of this total; however, it would appear reasonable that some of these would be listed eiders, perhaps in the tens for spectacled eiders, but fewer for Steller's eiders because their populations are smaller.

Accidental Oil Spills

While spills can occur on land or in the marine environment, spills to the marine environment have the greatest potential to affect large numbers of marine and coastal birds, including ESA-listed birds, because of their ability to spread and persist in coastal and marine environments. Exposure of spectacled and Steller's eiders and other marine and coastal birds is expected to result in the general effects reviewed below. This analysis assumes that all birds contacted by oil would not survive and that secondary effects may cause impaired physiological function and production of fewer young.

Small Spills. Section 4.1.2.5 and Tables 4-1 and 4-2 describe the assumptions concerning small crude oil spills. Of those two small crude oil spills ≥500 bbl, one is assumed to occur offshore and one is assumed to occur from the 300 mi onshore pipeline. If the ≥500 bbl crude oil spill occurred in close proximity to the LBCHU during the molting season and escaped containment, a large number of molting spectacled eiders could be contacted and be injured or killed. Steller's eiders close to the source of these spills also could be affected, but these birds are at lower densities and substantial effects would not be expected to occur. Pelagic species (e.g, shearwaters, auklets) tend to forage in dense concentrations. Given the wide distribution of pelagic seabirds, a spill may contact tens of thousands of pelagic birds, if they are foraging in dense concentrations near the spill site, or the spill could completely miss them if they are concentrated in another area.

The location of these small-volume spills would be an important factor in assessing impacts. Important areas known to receive frequent use, such as Peard Bay and Kasegaluk Lagoon, could be impacted. Such areas are considered "hot spots." The bird activity in these areas fluctuates widely based on the time of year and, for many shorebirds, can vary greatly (Powell, Taylor, and Lanctot 2010). For shorebirds in this area, a spill could impact tens of thousands of birds or very few, depending on the time of the spill, the quantity spilled, and the persistence of the oil and its effects.

Large Spills. Section 4.1.2.5 and Table 4-3 describe the assumptions concerning large crude oil spills.

Conditional Probabilities. This section discusses the chance that a large oil spill from the Leased Area could contact specific ERAs that are important to marine and coastal birds, including ESA-listed birds, assuming a hypothetical large spill occurs.

The OSRA model estimates conditional probabilities (expressed as a percent chance) of a large spill contacting marine and coastal bird habitats, assuming a spill occurs. The ERAs used in this analysis are shown in Table A.1-10 and Maps A.1-2a-f show their spatial locations. Conditional probabilities are based on the assumption that a large spill occurred (see definition and applications, Appendix A). The following analysis assesses impacts to ESA-listed birds (threatened Steller's and spectacled eiders) and then assesses impacts to other marine and coastal birds.

BOEM models large spills to estimate the percent chance that a large spill could contact important resources and then analyzes the potential effects from oil spills to determine which areas might have the highest chance of contact. In the following sections, BOEM evaluates the vulnerability of marine and coastal birds to oil spills (oil-spill analysis), and then describes the effect of disturbance from oil-cleanup activities, the effects of prey reduction or contamination, and the anticipated effects of that mortality on marine and coastal birds.

ESA-listed Birds

The potential for spills to contact ESA-listed species in the Chukchi Sea was described in the 2007 FEIS. Due to small adjustments in the ERA polygons (size/shape) and other model refinements, BOEM has updated the analysis for the Leased Area in the Chukchi Sea below.

Summer Spill. The following discussion summarizes the results for all LAs and PLs during summer, unless otherwise specified. The OSRA model estimates a <0.5-29% chance that a large spill starting at LAs will contact ERAs important to ESA-listed birds within 180 days, and a <0.5-59% chance from a PL (Table A.2-29). The LA10 has the highest chance (29%) of contact to ERA10 (Ledyard Bay Critical Habitat Unit, LBCHU). The chance of contact in this resource area is highest because the LA and the ERA are in proximity to or overlap each other (Appendix A, Maps). For PLs, the highest chance of contact to ERA10 is from PL6, which has a 59% chance of contact. As with the LAs, the chance of contact in this ERA is highest because the OSRA model's PLs and the ERA are in proximity to or overlap each other.

Spectacled eiders must stage offshore in the spring if their breeding habitats are unavailable. The ERA19 represents the spring lead system used by spectacled eiders during spring (April-June), and the highest percent chance of contacting ERA19 is 8% from any LA within 180 days (Table A.2-29). Similarly, a spill originating from PLs 6 or 9 has a 12-15% chance of contacting ERA19 within 180 days (Table A.2-29).

Most postbreeding spectacled eiders move offshore and then migrate west to the LBCHU (ERA10). A large spill from LAs 10 and 11 has a 14-29% chance of contacting the critical habitat area, which spectacled eiders use during the May-November open-water period (Table A.2-29).

Winter Spill. The following discussion summarizes the results for LAs 1, 4-6, and 10-11 and PLs 2-6 and 8-9 during winter, unless otherwise specified. The OSRA model estimates a <0.5-12% chance that a large spill starting at a LA contacts ERAs important to ESA-listed eiders within 180 days, and a <0.5-23% from a PL (Table A.2-53 and maps). A 180-day period is used in this analysis, because it allows an adequate time period for most winter spills to overlap with summer open-water period. If a large spill occurs during the winter season, it is assumed that at least part of the spill would not be cleaned up prior to ice breakup and, thus, it could contact one or more important habitat areas after ice breakup. The highest percent chance of contact from a LA occurs at ERA19, the spring lead system (April-June), which has a 26% chance of contact from LA11 and 23% from P6. The chance of contact in this ERA is highest because the OSRA model's LAs or PLs and the ERA are in proximity to or overlap each other (Table A.2-53 and maps).

Most postbreeding spectacled eiders move offshore and then migrate west to the LBCHU (ERA10). The OSRA model estimates a spill from LA10 or PL6 has a 3% or 10% chance of contacting ERA10 during winter, melting out in the spring. On an annual basis, a large spill from LA10 or PL6 has a 14% and 30% chance, respectively, of contacting ERA10 within 180 days (Table A.2-53).

Combined Probabilities. Combined probabilities differ from conditional probabilities in that they do not assume that a spill has occurred and consolidate nonuniform weighting of launch probabilities into one unit probability. The chance of one or more large spills occurring is multiplied by the area-wide probability that spilled oil would reach a particular ERA to estimate a combined probability that both would occur simultaneously. The combined probabilities of one or more large spills occurring and reaching ERAs of most concern to ESA-listed bird species are in Table A.2-73. The highest chance of contact during the assumed life of the Scenario is 14% to ERA 10, the LBCHU.

Anticipated Mortality. ESA-listed birds returning to the breeding grounds in spring often encounter sea ice in offshore areas and must stage in the Chukchi Sea before heading overland to nest sites. An excellent map depicting spectacled eider nesting areas is in Larned, Stehn, and Platte (2006: Figure 17). After breeding, the spectacled eider males often return overland to open waters in the Chukchi Sea spending little, if any, time in the Beaufort Sea. Late-departing males and failed nesting females may head north to open waters of the Beaufort Sea as spring progresses and coastal ice has receded. A few satellite-tagged males were relocated in Simpson Lagoon and Harrison Bay. In late August, once all the chicks in a nest hatch, the hen moves the brood to coastal areas for rearing. An increasing number of female and juvenile eiders move to these nearshore areas as the broodrearing season progresses. Once the chicks are flight capable, the broods move west out of the Beaufort Sea to molting areas in the Chukchi Sea, particularly Ledyard Bay. Bird mortality associated with an oil spill is likely to reflect local population size and vulnerability determined by seasonal habitat use and stage of annual cycle at the time of contact (for example, molting versus nonmolting).

A large oil spill contacting the LBCHU (ERA10) late in the open-water period could contact tens of thousands of molting eiders. As many as 33,000 eiders, including the entire cohort of successfully breeding females and their young, use the Ledyard Bay molting area at one time. The loss of all or part of the breeding female spectacled eiders of the ACP would result in a clear, long-lasting change in the resource's function in the ecosystem, and thus this would be considered a major impact to this species.

For many of the same reasons, a spill contacting the spring lead system could affect a relatively large proportion of the Steller's eider population staging enroute to the breeding grounds. A spill of this magnitude would result in a major impact on this species because they are clear, long-lasting and change the resource's function in the ecosystem.

Marine and Coastal Birds

The same assumptions and analytical process used to evaluate the potential effects of a large spill on ESA-listed birds was used on the other marine and coastal birds.

Summer Spill. The following discussion summarizes the results for all LAs and PLs during summer, unless otherwise specified.

Many pre- and post-breeding shorebirds and waterfowl stage at Kasegaluk Lagoon, while other bird species breed or molt in or near the lagoon. A large spill originating from PL6 or LA10 has a 19% or 9% chance, respectively, of contacting ERA1 (Kasegaluk Lagoon) within 180 days (Table A.2-29). Waterfowl and shorebirds also use Peard Bay, especially in the summer and fall to breed, molt, and forage during migration. A large spill originating from PL9 or LA11 has a 35% or 21% chance, respectively, of contacting nearby ERA64 (Peard Bay) (Table A.2 -29).

Many marine and coastal birds must stage offshore in the spring if their breeding habitats are unavailable. The ERA19 represents the Chukchi Sea spring lead system used by many of these birds during spring (April-June), and the highest percent chance of contacting this ERA is 9% from any launch area within 180 days, as they move east to breeding areas or stage offshore if breeding habitats were unavailable. Similarly, a large spill originating from PLs 6 or 9 has a 15 or 12% chance, respectively, of contacting ERA19, which marine and coastal birds use, within 180 days (Table A.2-29).

The OSRA model estimates a 13% chance of a large spill from PL3 contacting ERA15, directly adjacent to the murre breeding colonies near Cape Lisburne (Table A.2-29). This chance of contact also applies to other seabirds breeding at Cape Lisburne, including black-legged kittiwakes, puffins, and smaller numbers of glaucous gulls and pelagic cormorants. Similar species are located at colonies near Cape Thompson. The OSRA model estimates a much smaller chance of a large oil spill contacting ERA14 (Cape Thompson).

Many postbreeding waterfowl leave their nesting grounds and stage offshore in the Ledyard Bay (ERA10) area as they begin migration to the Bering Sea. A large spill originating from any LA has at most a 13% chance of contacting migrating marine and coastal birds in the ERA10 within 180 days (Table A.2-29). Similarly, PL6 has a 59% chance of contacting this ERA within 180 days.

Murres forage over a wide area of the Chukchi Sea during the breeding season and cover a much larger area later in 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 by ERA18. The OSRA model estimates a 20% and 25% chance of a large spill contacting ERA18 from LA10 and PL3, respectively (Table A.2-29).

Winter Spill. The following discussion summarizes the results for LAs 1, 4-6, and 10-11 and PLs 2-6 and 8-9 during winter, unless otherwise specified. The OSRA model estimates a <0.5-12% chance that a large spill starting at a LA contacts ERAs important to marine and coastal birds within 180 days, and a <0.5-23% from a PL (Table A.2-53 and maps). A 180-day period is used in this analysis, because it allows an adequate time period for most winter spills to overlap with summer open-water period. If a large spill occurs during the winter season, it is assumed that at least part of the spill would not be cleaned up prior to ice breakup and, thus, it could contact one or more important habitat areas after ice breakup. The highest percent chance of contact from an LA occurs at ERA19, the spring lead system (April-June), which has a 12% chance of contact from LA11 and 23% from P6. Many seaducks must stage offshore in spring if their breeding habitats are unavailable. The spring lead system (ERA19) is used by seabirds, seaducks, and other marine and coastal birds during spring. The chance of contact in this ERA is highest because the OSRA model's LAs or PLs and the ERA are in proximity to or overlap each other (Table A.2-53 and maps). The OSRA model estimates a spill from LA10 or PL6 has a 3% or 10% chance of contacting Ledyard Bay (ERA10) during winter, melting out in the spring. On an annual basis, a large spill from LA10 or PL6 has a 14% and 30% chance, respectively, of contacting ERA10 within 180 days (Table A.2-53).

Whereas Kasegaluk Lagoon and Peard Bay are important areas during open water in summer and fall, there would be less of a direct chance of contact to birds in these areas during winter, because most birds have migrated elsewhere for the winter and the bays and lagoons are frozen. However, if Peard Bay and Kasegaluk Lagoon were to become oiled in winter, there likely would be effects to the habitat and the birds as they return in spring and begin to forage and breed in these areas. A large spill originating from LA4 or LA5, however, only has a 1% chance of contact with these ERAs (all other LAs were <.05%). Similarly, PL6 has only a 2% chance of contacting marine and coastal birds in ERA1, Kasegaluk Lagoon with all other LAs having a <0.5% chance, including all PLs to Peard Bay (Table A.2-53).

Anticipated Mortality. Most marine and coastal birds are absent from the Chukchi Sea from early November to late April. Many birds returning to the breeding grounds in spring often encounter sea ice in offshore areas and must stage in the Chukchi Sea before heading overland to nest sites. Many of these birds congregate in the spring lead system, the only open water available.

Several species use the open waters of the Chukchi Sea for provisioning chicks, including loons, guillemots, puffins, murres, and murrelets. Postbreeding birds move to coastal areas for molting, staging, or broodrearing. Molting or other flightless birds are particularly vulnerable to oiling because of their limited mobility and the amount of time they spend in the water or in restricted habitats (e.g., coastal lagoons).

For the purposes of analysis, BOEM assumes that any birds, including seabirds, waterfowl, shorebirds, or others, in an ERA are killed if a large spill makes contact with that resource area. A large oil spill contacting the spring lead system could contact several thousand marine and coastal birds staging enroute to their nesting grounds farther east. The most abundant species are king and common eiders, long-tailed ducks, and smaller numbers of scoters, gulls, and loons. The OSRA model estimates that the percent chance of a large spill contacting marine and coastal birds using the Chukchi Sea lead system in spring would be a low-likelihood event, because to persist to that time and location, it would have to be released in the preceding winter.

After the lead system opens up to the open-water season, few birds are in this area because they have headed east to coastal or tundra breeding grounds. Later in summer, however, several prominent species congregate in coastal lagoons (Kasegaluk Lagoon in particular) to molt. These coastal lagoons are somewhat protected by barrier islands. Kasegaluk Lagoon, for example, contains aquatic plants used by large numbers of brant during the molt. If a spill were to enter the lagoon, it could impact a large proportion of the Pacific flyway population, which would be a major impact on this species.

Potentially much greater mortality could occur during migration periods as new migrants enter the spill area. However, unless migrant seaducks alight on the water during migration, they are not particularly susceptible to oiling. In addition, a spill in a particular area during summer could substantially affect those birds moving offshore from nesting areas much farther to the west. For example, a spill near Peard Bay would affect a substantial proportion of birds nesting on the eastern coastal plain as they moved toward the Chukchi Sea, and points farther east and south.

Juvenile murres are floating flightless at sea during their rearing period. Attendant male murres also are flightless while molting during this period. Spilled oil contacting ERA18 could result in extensive mortality, having a major impact on murres nesting at the Cape Lisburne and Cape Thompson colonies.

A large spill contacting ERA15, directly adjacent to the murre breeding colonies near Cape Lisburne, could affect other seabirds breeding at Cape Lisburne including black-legged kittiwakes, puffins, and smaller numbers of glaucous gulls and pelagic cormorants. Similar species are located at colonies near Cape Thompson. Spilled oil contacting this ERA during the May-November open-water period could result in a major impact on these species.

Spill-Response Activities. None of the conditional or combined probabilities factor in the effectiveness of oil-spill-response activities to large spills, which range from highly effective under ideal conditions to largely ineffective during unfavorable or broken-ice conditions. An OSRP would be required prior to oil exploration, development, and production (30 CFR 254).

Activities such as hazing (purposeful harassment of birds to keep them out of oiled habitats) and other human activities (vessel and aircraft traffic) could impact marine and coastal birds, including ESA-listed birds. Hazing may have limited success during spring when migrants occupy open-water ice leads. The hazing effect of cleanup activity or actively hazing birds out of ice leads that oil is expected to enter may be counterproductive because there are few alternative habitats that flushed birds can occupy. Cleanup activities in leads during May and open water in July through September are likely to affect marine and coastal birds, but may be unavoidable in responding to the spill.

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

Oil-spill response could originate from as far away as Deadhorse, about 150 mi (241 km) east of Barrow. Specific animal-deterrence activities would be employed as the situation requires and would be modified as needed to meet the current needs. The response contractor would be expected to work with various state and Federal officials on wildlife-management activities in the event of a spill. In an actual spill, the two aforementioned groups most likely would have a presence at the Incident Command Post to review and approve proposed hazing activities and monitor their impact on birds. As a member of the team, USFWS personnel would be largely responsible for providing critical information affecting response activities to birds in the event of a spill.

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

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

Prey Reduction or Contamination. Local reduction or contamination of food sources could reduce survival or reproductive success of the portion of populations occupying or nesting in the local area affected. This generally is not likely to affect a large proportion of any marine and coastal bird population because most species exhibit a dispersed breeding distribution. However, it could be more serious if these populations are experiencing a population decline, or if they were restricted to specific foraging habitats, i.e., seabirds foraging at sites adjacent to their breeding colony. Lowered food intake may slow the completion of growth in young birds, the replacement of female energy reserves used during nesting, and energy storage for migration of all individuals. However, the contamination of some local habitat areas is not likely to affect a large proportion of the population because they are likely to have access to alternative foraging habitat similar in appearance and with similar prey organisms present that is widely distributed in the region.

Conclusion. This time period involves the same activities as the exploration and development phases, but adds long-terms effects from platform installation, presence, and operation, as well as pipeline maintenance. Effects from disturbance/displacement along the 300 mi onshore pipeline route would persist across seasons. Chronic disturbances to nesting Arctic bird species would be widespread and would persist throughout the 15-year period.

The OSRA modeling indicates that the chance of contact from a large spill to ERAs important to marine and coastal birds is relatively low, but the possibility does exist. If such contact occurred, it would result in a clear, long-lasting change in the resource's function in the ecosystem, and thus this would be considered a major impact to a variety of marine and coastal bird populations in the Chukchi Sea.

The estimated bird/vessel encounter (mortality) rate is not anticipated to impact any one species to a population-level effect. Most marine and coastal bird populations are stable or robust, so the degree of loss would be recovered during the subsequent breeding cycle. Should any population decline, the potential impact to that species could increase. Also, if structures (i.e., MODUs and platforms) are located in areas known to support high densities of birds, such as Hanna Shoal and areas near Barrow Canyon, the number of bird:vessel encounters could be higher. Chronic disturbances to nesting spectacled eiders would be widespread and would persist throughout the 15-year period. Consequently, for routine oil and gas activities (i.e., no assumption of a large oil spill), the activities conducted during this time period are anticipated to have a moderate impact on marine and coastal birds, including threatened and endangered marine and coastal birds, because they are long-lasting and widespread, but less than severe. As stated above, the effects of climate change would be on-going. While the magnitude of potential effects from the Scenario on marine ande coastal birds is not anticipated to change, climate change could affect species could affect species composition, number and distribution.

Development and Production (Years 26-50)

Development and production activities during this period would continue in roughly the same manner and frequency as during the preceding period, analyzed above. This period includes construction of a satellite field and continuation of oil production. Construction activities would include installation of two additional production platforms and several offshore pipelines (Years 27-30, Table 4-4). There would be two deep penetration seismic surveys and infrequent high-resolution surveys. A terrestrial gas pipeline would be constructed during the winter, when marine and coastal birds would be absent. No exploration drilling is anticipated.

Noise and disturbance impacts as a result of new construction activites and/or seismic surveys would be minimal as these marine and coastal birds typically avoid areas of industrial activity and these activities would not occur in critical habitats (i.e., LBCHU and spring lead system). There would be temporary, localized effects to offshore habitats from dredging/pipe laying and suspension of sediments during offshore pipeline/service line construction, but these effects would not persist across seasons.

Construction of a terrestrial gas pipeline would result in direct loss of spectacled eider nesting habitat. Similar loss of nesting habitat for other marine and coastal bird species could be expected. These effects were analyzed for threatened and endangered birds in the Biological Assessment (USDOI, BOEM, 2015, p. 102) and the Biological Opinion (USFWS, 2012, page 88). Installing this pipeline adjacent to the oil pipeline could minimize effects. Long-term access and maintenance would displace birds along this corridor indefinitely.

Production platforms and vessels would continue to remain an obstacle to marine and coastal birds in the offshore environment. The maximum number of encounters would occur during Year 29, when an estimated 459 birds would encounter vessels/platforms. The composition of these encounters is estimated to be 96 seabirds, 124 seaducks, 37 shorebirds, and 202 passerines. Of the 124 seaducks, only a few would likely be listed eiders, perhaps less than 10 spectacled eiders per season. Steller’s eiders would be expected to be involved in fewer encounters because their populations are smaller. Several other seaduck populations have experienced periodic declines (e.g., king eider, common eider) and the potential impact to those species could increase. In a declining population, losses are not recovered by recruitment. The distribution of these strike effects across all marine and coastal species and species groups is such that no species would experience more than 50 mortalities, a moderate impact.

Accidental small and large oil spills during the development and production phase are estimated in Tables 4-1, 4-2 and 4-3. The duration of spill characteristics in the environment would be variable and consistent with those described for small oil spills during the Exploration Phase or small and large spills in the Exploration, Development, and Production Phase.

Gas Releases

The release and flaring of 10 million ft^3 (283 thousand m^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 major impact if these bird losses were not recovered within a generation. No 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.

Conclusion. This time period involves the same activities as the exploration and development phases, but at a reduced level. Long-terms effects from platform and pipeline installation and operation/maintenance continue. Effects from disturbance/displacement along the 300 mi oil/gas pipeline route would persist across seasons. Additional direct effects include the physical presence of more platforms in the marine environment and birds striking platforms and construction/seismic survey vessels could be killed. Maximum estimated mortality per season during this period would be 459 birds (Year 29). The distribution of these effects across species and species groups is such that no species would experience more than 50 mortalities, a moderate impact. While a small proportion of this mortality could be threatened and endangered marine and coastal birds, this mortality rate is not anticipated to impact any one species to a population-level effect. However, as previously stated, if structures (i.e., MODUs and platforms) are located in areas known to support high densities of birds, such as Hanna Shoal and areas near Barrow Canyon, the number of bird:vessel encounters could be higher. Also, should any population decline, the potential impact to that species could increase. Several seaduck populations have experienced periodic declines (e.g., king eider, common eider) and the potential impact to those species could increase. Chronic disturbances to nesting spectacled eiders would be widespread and would persist throughout the 24-year period. Overall, however, oil and gas activities conducted during this time period are anticipated to have a moderate impact on marine and coastal birds, including threatened and endangered species, because they are long-lasting, widespread, and less than severe. If a large oil spill occurs, there would be a clear, long-lasting change in the resource's function in the ecosystem, and thus this would be considered a major impact. As stated above, the effects of climate change would be on-going. While the magnitude of potential effects from the Scenario on marine and coastal birds is not anticipated to change, climate change could affect species composition, number and distribution.

Production and Decommissioning (Years 51-77)

Production activities will have become routine as oil production shifts to gas production. No additional construction or seismic survey activities are anticipated. Production platforms remain obstacles to marine and coastal birds in the offshore environment. The removal of these platforms would begin in Year 60 and the removal of each platform could benefit marine and coastal birds by reducing bird encounters each season thereafter. There is, however, an extended period (Years 54-65) of additional drill rig activity for the purpose of plugging and decommissioning of the subsea wells, and this activity increases effects to birds. Years 57-61 would have three exploration drilling rigs and support vessels, contributing to a total of 1,044 bird encounters per season, the highest level during this period. The assumed seasonal mortality during the Year 57-61 period is estimated to be 282 seaducks, 219 seabirds, 84 shorebirds, and 459 passerines.

It would appear reasonable that some of the 282 seaduck strikes would be listed eiders, perhaps tens of spectacled eiders, but fewer for Steller's eiders because their population is smaller. The distribution of strike effects across species and species groups is such that several seaduck or seabird species would experience more than 100 mortalities, a major impact. Several seaduck populations have experienced periodic declines (e.g., king eider, common eider) and the potential impact to those species could increase. In a declining population, losses are not recovered by recruitment. Overall, the activities conducted during this time period are anticipated to have a major impact on marine and coastal birds.

Accidental small and large oil spills during the development and production phase are estimated in Tables 4-1, 4-2 and 4-3. The duration of spill characteristics in the environment would be variable and consistent with those described for small oil spills during the Exploration Phase or small and large spills in the Exploration, Development, and Production Phase.

Conclusion. This time period involves the same activities as the previous phase, but there would be no additional construction and drill rig activity is intensified at the mid-point. Platforms would gradually be removed. Long-terms effects from platform and pipeline operation/maintenance would continue, but at a reduced level. Effects from disturbance/displacement along the 300 mi oil/gas onshore pipeline route would persist, but at a reduced level. The bird encounter risk from platforms in the marine environment would decline as they are removed. Exploration drilling activity, however, could result in increased number of bird:vessel encounters. Maximum estimated mortality per season during this period would be 1,044 birds (Years 57-61). The distribution of these effects across species and species groups is such that several seaduck or seabird species would experience more than 100 mortalities, a major impact. Several seaduck populations have experienced periodic declines (e.g., king eider, common eider) and the potential impact to those species could increase. In a declining population, losses are not recovered by recruitment.

While a small proportion of this mortality could be threatened and endangered marine and coastal birds, this mortality rate is not anticipated to impact any one species to a population-level effect. Should any population decline, the potential impact to that species could increase. Chronic disturbances to nesting spectacled eiders and many other Arctic-nesting species would remain along the pipeline corridor and would persist throughout the period. Overall, the activities conducted during this time period are anticipated to have a major impact on marine and coastal birds. As stated above, the effects of climate change would be on-going. While the magnitude of potential effects from the Scenario on marine and coastal birds is not anticipated to change, climate change could affect species composition, number and distribution.

Conclusion

There are several impact producing factors that could affect marine and coastal birds. Most of these (vessel/drilling/aircraft noise, physical presence, habitat alteration, and discharges) would have minimal effects because birds typically avoid areas of industrial activity. Oil and gas exploration and development activities are not anticipated to occur in critical habitats, such as the LBCHU or the spring lead system. There are brief periods of construction activity that have localized, short-term effects; however, the footprints of some facilities in the terrestrial environment would result in permanent loss of bird nesting habitat, including spectacled eider nesting habitat. While there remains uncertainty about the location(s) of onshore development, protections, including avoidance and other forms of mitigation, of the important habitat in the Barrow vicinity are expected, however, from the multi-tiered decision making and review process in place for exploration and onshore development planning. Long term operation of pipelines necessitates access along the route, and this access brings disturbance that could displace nesting birds away from the pipeline corridor. For routine oil and gas activites (which do not include oil spills, which are unauthorized activities), the greatest amount of direct harm could come from birds, including listed eiders, striking MODUs, offshore platforms, and support or construction vessels. While the marine and coastal bird:vessel encounters are estimated to exceed a thousand marine and coastal birds during several periods of the Scenario, only a portion of these are seaducks and an even smaller proportion of these are anticipated to be listed eiders. Anticipated impacts to marine and coastal birds from the Scenario range from minor during the exploration-only period (Years 1-5) to moderate during periods 2 (Years 6-9) and 4 (Years 26-50) where exploration activities overlap with development and initial production activities. Platforms are obstacles to birds in the marine environment and are a long-term source of bird mortality. A major impact is anticipated to occur where exploration drilling coincides with a large number of offshore platforms, periods 3 (Years 10-25) and 5 (Years 51-77). Once exploration drilling ceases, impacts are reduced, with lower levels of effects. While marine and coastal bird mortality appears large, it is anticipated to be distributed across many species. Several species (e.g., king eiders, common eiders, short-tailed shearwaters) could experience mortality exceeding 100 birds per season. Other species would have a relatively lower anticipated impact because of their nesting habitats and population size. The level of potential mortality to marine and coastal birds, combined with habitat loss and long-term disturbances from pipeline corridor maintenance for the entire Scenario are anticipated to result in major impacts on marine and coastal birds, especially seaducks and seabirds. The impacts are expected to have long-lasting changes in the resource's function in the ecosystem. While the magnitude of potential effects from the Scenario on marine and coastal birds is not anticipated to change, climate change could affect species composition, number and distribution.

ESA-Listed species. Spectacled eiders would be the most impacted of the listed species, with with potential direct effects to nesting habitats as well as likely direct mortality from vessel encounters. The other listed species would have relatively lower anticipated impacts because of their nesting habitats and population size. However, as described above, for routine oil and gas activites, the greatest amount of direct harm could come from birds striking MODUs, OCS platforms, and support or construction vessels. The potential effect of strikes increases when species are in decline; thus, the potential level of mortality to these species, combined with habitat loss and long-term disturbances from pipeline corridor maintenance for the entire Scenario are anticipated to result in a major impact. However, on threatened and endangered marine and coastal birds, especially the spectacled eider. BOEM's impact analysis is somewhat restricted by the following: (1) Bird strike risk was estimated using limited data, i.e., data from a single drilling program, operating for one season, 2012, in the Chukchi Sea; (2) Seaducks as a group accounted for only 27% of those encounters, and none of the reported encounters included listed eiders; and (3) BOEM overestimated level of impact by assuming all birds making contact with vessels are mortailities.

In a NEPA context, therefore, these collision estimates are likely overly conservative. Furthermore, should exploration or development and production activitites commence, other regulatory processes would limit the impacts to listed species. As described in Chapter 6 of the 2007 FEIS, BOEM and BSEE have previously consulted with the USFWS regarding this lease sale resulting in a Biological Opinion which includes terms and conditions, and reasonable and prudent measures to protect listed species and ensure activites do not jeopardize the continued existence of the species. Consultation has also been reinitiated in light of the Scenario used in this Second SEIS, and to account for any new information available since the Biological Opinion was issued. Consultation is ongoing, and should the USFWS identify any new terms and conditions and reasonable and prudent measures, BOEM and BSEE would apply them to any activities that may result from Lease Sale 193.

Mitigation Measures

The effects of the Scenario on marine and coastal birds may be modified by application of mitigation measures. Measures outlined in Lease Stipulations (Appendix D) and Information to Lessees (www.boem.gov/ak193) provide for specific protective measures, as well as for development of future measures that protect unique biological communities. For example, to minimize impacts to marine and coastal birds from collisions with MODUs, vessels, and platforms, Lease Stipulation 7 provides lighting protocols to minimize the likelihood that birds will strike drilling structures and vessels. This stipulation also requires development of a plan for monitoring, recording, and reporting bird strikes. Stipulation 7 also specifies that aircraft support should not fly below 1,500 feet to the maximum extent practicable to avoid disturbing birds. Information to Lessee (ITL) No. 2 (Bird and Marine Mammal Protection), ITL No. 7 (Spectacle Eider and Steller's Eider), and ITL No. 8 (Sensitive Areas to be Considered in Oil-Spill-Response Plans) provide general recommendations and best management practices to minimize impacts to marine and coastal birds. Also, ramp up procedures that would likely be used as a mitigation measures to avoid/minimize impacts to marine mammals would also benefit birds. In addition, an oil-spill response plan would be required prior to exploration or development and production activities (30 CFR 254). The effects of small spills to all resources would be limited by requirements such as spill-catchment equipment on vessels, MODUs, and at land facilities; deployment of booming equipment during offshore fuel transfers; and automatic shutdown of fuel lines triggered by decreased pressure.

4.3.6.2. Alternative II- No Action

Under Alternative II, Lease Sale 193 would not be affirmed and no leases would be available for further exploratory drilling or for development within the Leased Area. Impacts from exploratory drilling, pipeline route clearance, shallow hazard surveys, and other activities related to on-lease exploration and subsequent production would not occur unless additional lease sales were held and leases were issued at a later date. Pre-lease exploration activities (which are not tied to leases), such as various seismic surveys, would likely occur. Impacts from vessel traffic and noise associated with these activities would continue; however, these impacts are short-term and localized. Selecting Alternative II would result in a negligible impact to marine and coastal birds.

4.3.6.3. Alternative III- Corridor I Deferral

Alternative III provides the largest deferral area of the action alternatives – a corridor approximately 60 miles (97 km) wide along the Chukchi Sea shoreline. If Alternative III were selected, the distance from the shore to many activities could be greater than under Alternatives I and IV. No exploration or development drilling or platform construction would occur within the corridor, although certain activities (i.e., installation of a pipeline extending from the leases outside the corridor to the shore) could occur there. Of the Lease Sale 193 leases, only five are within Corridor I.

The minimum distance from shore under Alternative III could be slightly greater for the following than under the other action alternatives: length of pipeline from a platform to shore; travel distances from vessels and aircraft; source of discharges, emissions and noise from drilling and platforms; and, potentially the source of a large OCS oil spill.

Under Alternative III, the increased distance between OCS exploration and development activities and coastal bird habitats could slightly decrease the likelihood of accidental spills and gas releases contacting nearshore areas, increase weathering of spilled oil, and increase available spill response time. The primary benefit of the corridor is that it would move some sources of potential adverse effects farther away from important bird habitats, particularly staging and molting areas. Using the Impacts Scale in Section 4.2, the level of impacts under Alternative III would be consistent with the other action alternatives.

4.3.7. Marine Mammals

4.3.7.1. Alternatives I and IV

The 2007 FEIS and 2011 SEIS analyzed certain species (birds and marine mammals) in a Threatened and Endangered section, and other birds and marine mammals in separate sections. For this Second SEIS, Marine and Coastal Birds and Marine Mammals are each given sections, with attention to Threatened and Endangered species within the larger resource group.

Impact Producing Factors

This section identifies the Impact Producing Factors (IPFs) resulting from the oil and gas activities associated with the Scenario, and discusses the manner in which each identified IPF can affect various species of marine mammals. IPFs are organized by phase of oil and gas activity (i.e. exploration, development, production, and decommissioning). IPFs which occur during multiple phases are addressed in the phase in which they first appear; these discussions are then referenced where applicable.

Accidental spills, though not considered routine oil and gas activities, have the potential to occur during each phase of the Scenario. General impacts of small and large spills are addressed as IPFs in the subsection where they have the potential to occur. The impacts of spills within the larger context of all other activities that occur during each period are analyzed in this section under Impacts of the Scenario Through Time.

Aspects of the Scenario with the greatest potential to affect marine mammals are seismic survey noise, sonar noise, drilling noise, bottom disturbance and alteration, icebreaking/ice-management, vessel noise, aircraft noise, construction activity noise, habitat disturbance, and the physical presence of vessels, aircraft, platforms and drilling. These impacts are analyzed in detail in the 2007 FEIS (pages IV-81 – IV-125 and IV-145 – IV-171) and in the 2011 SEIS (pages IV-104 – IV-111, IV-114 – IV-116, IV-191 – IV-225, and IV-235 – IV-235 – IV-250). Relevant portions of those analyses are incorporated by reference and summarized below. This section also incorporates new information that has become available since the 2011 SEIS and other information pertinent to understanding impacts from the Scenario described in Section 2.3.5.

Exploration

Noise

Marine mammals such as cetaceans and pinnipeds use sound, sight, olfaction, and somatic senses to interact with their environment. Anthropogenic sound can affect marine mammals in a number of ways to include:

- Behavior disruption
- Sound masking
- Hearing loss
- Producing physiological stress or injury, and
- Creating ecosystem changes

The ability of marine mammals to detect and generate sound may vary greatly between species based on differences in sound characteristics such as frequency, bandwidth, energy, directionality, and temporal patterns of the sound. Furthermore, oceans are naturally very noisy, and often contain many concurring sounds which marine mammals must be able to perceive and sort with precision. The frequency bands and source levels of common offshore oil and gas activities and the hearing frequencies of Arctic marine mammal groups are depicted in Figure 4-8.

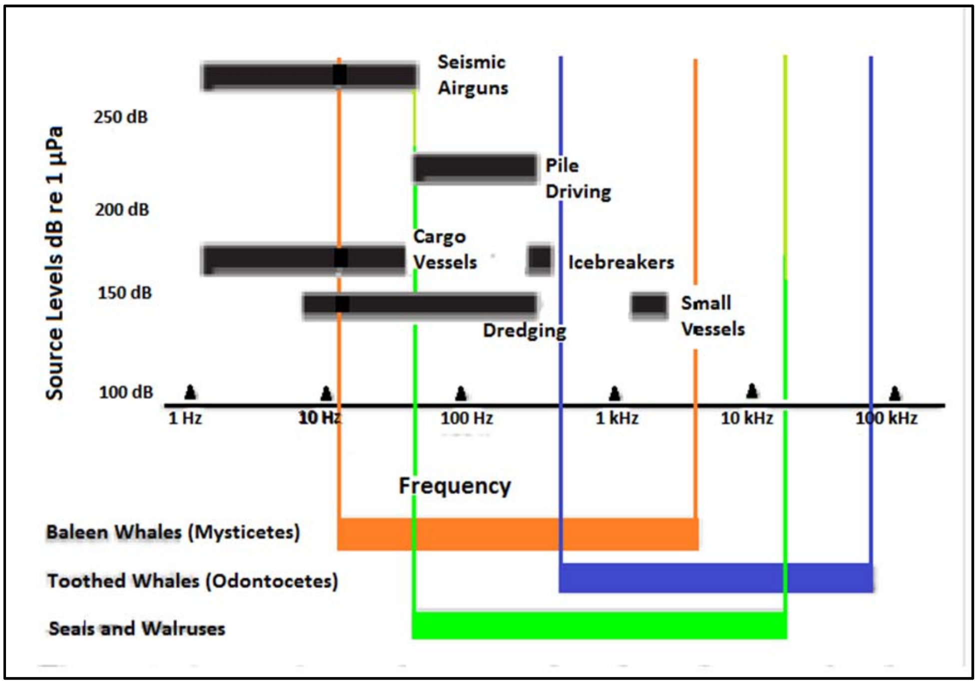


Figure 4-8. Frequency Bands and Source Levels for Common Arctic Offshore Activities. *Source: (Moore et al., 2012; Greene, 1995)*

The data in Figure 4-8 are analyzed in Moore et al. (2012), taking data from Greene (1995), and show the frequency range audible to seals occuring between 75 Hz – 75 kHz, whereas walruses use a 100 Hz – 50 kHz frequency range (Finneran and Jenkins, 2012. Table 4-44 shows the boxcar frequency range for phocid seals occurring between 50 Hz - 80 kHz.

Table 4-44. Boxcar Frequency Range – Marine Mammals Using Navy Acoustic Effects Model.

Species Group	Limit (Hz)	
	Lower	Upper
LF Cetaceans	5	30,000
MF Cetaceans	50	200,000
HF Cetaceans	100	200,000
Otariid Pinnipeds, Walruses, Sea Otters, Polar Bears (in water)	20	60,000
Phocid Pinnipeds, Sirenians (in water)	50	80,000

Source: Ciminello et al., 2012

In comparison, the low-frequency hearing group of cetaceans that includes the mysticetes whales has a hearing range between 7 Hz – 22 kHz (Finneran and Jenkins, 2012), shown as 5 Hz – 30 kHz in Table 4-44. Mid-frequency cetaceans including killer whales and beluga whales occurs in the 150 Hz – 160 kHz range (Finneran and Jenkins, 2012), but in Table 4-44 show a 50 Hz – 200 kHz frequency range. Lastly, the high-frequency cetacean group, which includes harbor porpoises, uses a 200 Hz – 180 kHz frequency range according to Finneran and Jenkins (2012) but Table 4-44 shows them having a 100 Hz – 200 kHz boxcar frequency range, consequently the auditory bandwidth used by harbor porpoises is conservatively estimated at the extreme ends of the two estimates (100 Hz – 200 kHz) since Finneran and Jenkins (2012) were mainly analyzing acoustic thresholds for TTS and PTS for pulsed noises. Consequently, different marine mammal species would be affected to differing degrees by the IPFs in the Scenario. The following analyses address the effects of the IPFs to each marine mammal species over the 77-year life of the Scenario.

Ciminello et al. (2012) analyzed the effects of noise on marine mammals using existing data and compiled noise criteria and threshold tables of Non-impulsive (continuouse) and Impulsive noise for marine mammals (Tables 4-45 and 4-46).

Table 4-45. Non-Impulsive Thresholds and Criteria for Marine Mammals

Group	Species	PTS Onset	TTS Onset	Behavioral Criteria
LF Cetaceans	Bowhead, Fin, Gray, Humpback, Minke	198 dB SEL (Type II weighted); 230 dB Peak SPL	178 dB SEL (Type II weighted); 224 dB Peak	Mysticete Dose Function (Type I
MF Cetaceans	Beluga and Killer Whales	198 dB SEL (Type II weighted); 230 dB Peak SPL	178 dB SEL (Type II weighted); 224 dB Peak SPL	Odontocete Dose Function (Type I weighted)
HF Cetaceans	Harbor Porpoise	172 dB SEL (Type II weighted)	152 dB SEL (Type II weighted); 195 dB Peak SPL	120 dB SPL, unweighted
Phocidae (in water)	Bearded, Spotted, Ribbon, and Ringed Seals	197 dB SEL (Type I weighted); 235 dB Peak SPL	183 dB SEL (Type 1 weighted); 229 dB Peak SPL	Odontocete Dose Function (Type I weighted)

Source: Ciminello et al., 2012

Table 4-46. Impulse Criteria and Thresholds for Marine Mammals

<table>
<tr><th>Group</th><th>Species</th><th>Onset Mortality</th><th>Onset Slight Lung Injury</th><th>Onset Slight GI Tract Injury</th><th>Onset PTS</th><th>Onset TTS</th><th>Behavioral (for >2 pulses/24 hr)</th><th>Non-Explosive Impulsive Source (NMFS Level A)</th><th>Non-Explosive Impulsive Source (NMFS Level B)</th></tr>
<tr><td>LF Cetaceans</td><td>Bowhead, Fin, Gray, Humpback, Minke Whales</td><td rowspan="2">Note 1</td><td rowspan="2">Note 2</td><td rowspan="2">237 dB SPL (104 psi)</td><td>187 dB SEL (Type II weighted) or 230 dB Peak SPL</td><td>172 dB SEL (Type II weighted) or 224 dB Peak SPL</td><td>167 dB SEL (Type II weighted)</td><td>180 dB SPL KMS3</td><td>160 dB SPLRMS</td></tr>
<tr><td>MF Cetaceans</td><td>Beluga, Killer Whales</td><td>187 dB SEL (Type II weighted) or 230 dB Peak SPL</td><td>172 dB SEL (Type II weighted) or 224 dB Peak SPL</td><td>167 dB SEL (Type II weighted)</td><td>180 dB SPLRMS</td><td>160 dB SPLRMS</td></tr>
</table>

Group	Species	Onset Mortality	Onset Slight Lung Injury	Onset Slight GI Tract Injury	Onset PTS	Onset TTS	Behavioral (for >2 pulses/24 hr)	Non-Explosive Impulsive Source (NMFS Level A)	Non-Explosive Impulsive Source (NMFS Level B)
HF Cetaceans	Harbor Porpoises				161 dB SEL (Type II weighted) or 201 dB Peak SPL	146 dB SEL (Type II weighted) or 195 dB Peak SPL	141 dB SEL (Type II weighted)	180 dB SPL	160 dB SPL
Phocidae (in water)	Bearded, Spotted, Ribbon, Ringed Seals				192 dB SEL (Type I weighted) or 218 dB Peak SPL	177 dB SEL (Type I weighted) or 212 dB Peak SPL	172 dB SEL (Type I weighted)	190 dB SPLRMS	160 dB SPLRMS
Obodenidae Water	Pacific Walruses				215 dB SEL (Type I weighted) or 218 dB Peak SPL	200 dB SEL (Type I weighted) or 212 dB Peak SPL	195 dB SEL (Type I weighted)	190 dB SPLRMS	160 dB SPLRMS
Ursidae Water	Polar Bears							190 dB SPLRMS	160 dB SPLRMS

Notes: Note 1: = $91.4M^{1/3}$(1=[DRM/10.081])1/2 Pa-sec, where M = mass of animals in kg and DRM = depth of receiver (animal) in meters.

Note 2: = 39.1M1/3 (1+[DRM/10.081])1/2 Pa-sec, where M=mass of animals in kg and DRM = depth of receiver (animal) in meters.

Note 3: RMS refers to 90% of the energy under the envelope, per NMFS OPR.

Source: adapted from Ciminello et al., 2012

Acoustic exposures can result in three main forms of noise-induced losses in hearing sensitivity:

- When a permanent loss of hearing sensitivity, or Permanent Threshold Shift (PTS), occurs, physical damage to the sound receptors (hair cells) in the ear has occurred. Such damage produces partial to total deafness within a frequency range permanently.
- Investigations of temporary loss of hearing sensitivity, or Temporary Threshold Shifts (TTS), have focused on sound receptors (hair cell damage), concluding this form of threshold shift is temporary. Since hair cell damage does not occur in a TTS, hearing losses are temporary with recovery periods that can last minutes, days, or weeks. Kujawa and Liberman (2009) reported noise-induced degeneration of the cochlear nerve that was a delayed result of TTS producing acoustic exposures. Those exposures produced TTS states for the subject animals that occurred in the absence of hair cell damage, but was irreversible. They concluded that the reversibility of noise induced threshold shifts, or TTS, can disguise progressive neuropathology that would have long-term consequences on an animal's ability to process acoustic information. If this phenomenon occurs in a wide range of species, TTS may have more permanent effects on an animal's hearing sensitivity than earlier studies suggest.
- Compound threshold shift or CTS, occurs when some loss in hearing sensitivity is permanent and some is temporary (for example, there might be a permanent loss of hearing sensitivity at some frequencies and a temporary loss at other frequencies or a loss of hearing sensitivity followed by partial recovery).

PTS and TTS criteria may be measured using SEL, which requires the accumulation of energy from every ping/pulse within each of four frequency bands (Ciminello et al., 2012), or SPL (NMFS, 2013b):

- Low-frequency
- Mid-frequency
- High-frequency
- Very high-frequency

Though PTS and TTS may be measured using the SPL or SEL metrics, NMFS has historically used SPL to determine harassment as defined under the MMPA. The noise levels NMFS uses are 190 and 180 dBrms SPL for Level A harassment threshold criteria, where permanent injury to marine mammal ear structures could occur (Table 4-47). These noise levels may extend 10s of meters from a noise source before attenuating out, and are typically produced by seismic surveys, ancillary activities, and icebreaking. The 160 and 120 dBrms SPL noise levels are used as the noise threshold for the onset of Level B harassment with respect to impulsive and non-pulsed noises respectively (Table 4-47). These noises may begin at the source, such as with drilling, construction, and pile-driving, and may extend out for several miles depending upon the activity and source levels (NMFS, 2013b, p. 197-198).

120 dB is the threshold used for Level B harassment for continuous noise (NMFS, 2013b, p. 197-198).

Table 4-47. NOAA Fisheries Current In-Water Acoustic Thresholds.

Criterion	Criterion Definition	Threshold
Level A	PTS (injury) conservatively based on TTS	190 dB_{rms} for pinnipeds 180 dB_{rms} for cetaceans
Level B	Behavioral disruption for impulsive noise (e.g., impact pile driving)	160 dB_{rms}
Level B	Behavioral disruption for non-pulse noise (e.g., vibratory pile driving, drilling)	120* dB_{rms}

Notes: Thresholds exclude tactical sonar and explosives.
All decibels referenced to 1 micro Pascal (re: 1µPa). All thresholds are based off root mean square (rms) levels.
*The 120 dB threshold may be slightly adjusted if background noise levels are at or above this level.

Source: NOAA Fisheries, West Coast Region Interim Sound Threashold Guidance at: http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html

NMFS (2013b, Table 1) shows distances from industry continuous noise sources to ambient noise levels of approximately 120 dB re 1 µPa, the noise level generally used to represent "harassment" of marine mammals under the Marine Mammal Protection Act (Table 4-48).

Table 4-48. Range From Low-frequency Noise Source to 120 dB re 1 µPa.

Low-Frequency Noise Source	Distance from source levels to 120 dB re 1 µPa
a. Drillship	10 km / 6 mi
a. Jack-up Drilling	1 km / 0.60 mi
a. Support Vessel (Offshore)	1.60 km / 1 mi
a Icebreaker	8 km / 4.97 mi
b. 2D/3D Seismic Airgun Array (3,147 in^3) (51.6 L0	120 km / 74.56 mi
b. Mitigation Airgun (30 in^3) (0.49 L)	47 km / 29.20 mi
c. Pile Driving	1 km / 0.60 mi
d. Dredging	25 km / 15.53 mi

Note: Distance From Low-frequency Noise Sources to 120 dB re 1 µPa (ambient) Noise Levels.Data.

Sources: a. (NMFS, 2013b); b. (Funk et al., 2008); c. (Blackwell, 2005); d. (Richardson, Würsig, and Greene, 1990).

Airgun Noise - 2D/3D Seismic Surveys. Marine seismic survey noise is produced in pulses by using airguns to discharge high-pressure air into water. When used in seismic surveys, airguns are linked together and towed behind seismic vessels in arrays, firing every 10-15 seconds. Individual airguns emit source noise levels of 233-240 dB re 1 µPa at 1m, in 10-15 second intervals, depending on the traveling speed of the survey and airgun size. Airgun size is measured by the cubic inches (in^3) of high-pressure air they discharge into the water, and may vary from 10s to 100s of cubic inches. The size of airgun arrays is measured by the collective size of all airguns in the array. Most airgun arrays used in the Leased Area should range from 1,800 – 4,200 in^3 (29.5-68.8 L) ; however, arrays up to 6,000 in^3 (98.3 L) may be used, and a survey vessel may tow up to three airgun arrays.

Most airgun noise is focused beneath the airgun array, though some noise radiates horizontally from firing airgun arrays. Horizontally radiated noise quickly attenuates in the ocean, with decibel levels dropping from source levels to much lower levels in a few tens of meters (Blackwell et al., 2013; Greene and Moore, 1995). It is suspected that close proximity or long-term exposure to airgun noise could have effects on marine mammals, including hearing loss and elevated stress levels; it could also elicit behavioral disruptions (Richardson, 1995; Richardson and Würsig, 1995).

During ancillary activities, smaller airgun arrays may be used to survey small portions of the Leased Area. The smaller size and shorter duration of ancillary airgun array use would result in effect levels below that of marine seismic surveys. The use of mitigation guns would be even lower levels of effect due to the duration and intensity of sound they produce.

Geohazard high frequency surveys: Sonar noise occurs at higher frequencies that lie beyond the hearing capabilities of some marine mammals. For example, pinnipeds generally hear noises in the 75 Hz – 75 kHz range; some sonar, such as Sidescan sonar, occur in the 100-1600 kHz range, which is beyond the hearing abilities of seals.

- Sidescan Sonar. Side scan sonar is a sideward-looking, narrow-beam instrument that emits a sound pulse and "listens" for its return. The side scan sonar can be a two channel or multichannel system with single frequency monotonic or multiple frequency Compressed High Intensity Radar Pulse (CHIRP) sonar acoustic signals. The frequency of individual side scan sonars can range from 100 to 1600 kHz with source levels between 194 and 249 dB re 1 µPa at 1 m (rms). Pulse lengths will vary according to the specific system: monotonic systems range between 0.125 and 200 milliseconds (ms) and CHIRP systems range between 400 and 20,000 ms (HydroSurveys, 2008; Dorst, 2010). Noises in the frequency range used by sonar should be inaudible to many marine mammals with low-frequency hearing, but audible to marine mammals that hear in the mid-frequency to high-frequency sound spectrum, such as harbor porpoises and killer whales. Effects of sonar noise on marine mammals in the Leased Area could involve no effects, behavioral effects, or physiological effects, depending on the species.
- Echosounder. Echosounders measure the time it takes for sound to travel from a transducer to the seafloor and back to a receiver. The travel time is converted to a depth value by multiplying it by the sound velocity of the water column. Single beam echosounders measure the distance of a vertical beam below the transducer. The frequency of individual single beam echosounders can range from 3.5 to 1,000 kHz with source levels between 192 to 205 dB re 1 µPa at 1 m (rms) (Koomans, 2009). Multibeam echosounders emit sound to both sides of the transducer with frequencies between 180 and 500 kHz and source levels between 216 and 242 dB re 1 µPa at 1 m (rms) (Hammerstad, 2005; HydroSurveys, 2010). Multi-beam and single-beam echosounder noise should be audible to marine mammals that hear in low-,mid-, and high-frequency sound spectrums. Depending upon the species, there could be no effects, avoidance behavior, or physiological effects.
- High Resolution Profilers. High-resolution seismic reflection profilers, including subbottom profilers, boomers, and bubblepulsers, consist of an electromechanical transducer that sends a sound pulse down to the seafloor. Sparkers discharge an electrical pulse in seawater to generate an acoustic pulse. The energy reflects back from the shallow geological layers to a receiver on the subbottom profiler or a small single channel streamer. Such systems range in frequency from 0.2 to 200 kHz, with source levels between 200 and 250 dB re 1 µPa at 1 m (rms) (Laban et al., 2009; Greene and Moore, 1995). High resolution profiler noise should be audible to marine mammals that hear in low-,mid-, and high-frequency sound spectrums and may have no effects, cause avoidance behavior, or cause physiological effects, with the effects varying by species.

Vessel Noise. Variables that help determine whether marine mammals are likely to be disturbed by vessels include the number of vessels in an area, the distance from a vessel, vessel speed and direction, vessel noise, vessel type or size, and activity of the marine mammal.

Vessels associated with exploration activities operate primarily during open-water and early winter periods. Vessels effects include visual presence, traffic frequency and speed, and operating noise of on-board equipment and engines; in the case of icebreakers, impacts also include ice breakage noise. Marine mammals may be exposed to vessels when seasonal distribution and habitat selection overlaps in time and space with proposed exploration vessel activities. For offshore oil and gas exploration, operations vessels provide the primary platform for open-water season seismic surveys, and secondary support for these surveys such as monitoring, crew transfer, fuel, and equipment and supplies delivery. Vessels also provide similar support functions for the transport, placement, construction and operation of Mobile Offshore Drilling Units (MODUs) (as defined in Chapter 2).

- **Small Vessels.** Small vessels (55-85 m) and boats (<55 m) typically produce noise in frequency ranges from 37 to 6300 Hz, and 152 to 170 dB re 1 μPa noise levels, while small ships generally produce noise levels between 170-180 dB re 1 μPa in a similar frequency range (Richardson, 1995). Broadband source levels (at 1 m) for most small ships are in the 170-180 dB re 1 μPa range, excluding infrasonic components (Greene and Moore, 1995). The actual noise produced could vary greatly due to vessel size, engine size, engine type, hull structure, number and placement of propellers, and vessel speed.

  Broadband underwater sounds from the supply ship Robert Lemeur in the Beaufort Sea were 130 dB at a distance of 0.56 km (Greene, 1987), and were 11 dB higher when bow thrusters were operating than when they were not (Greene, 1985, 1987). The Robert Lemeur has nozzles around the thruster propellers. Broadband sound levels from ships lacking nozzles or cowled propellers may be ≥10 dB higher than those from ships with the nozzles (Greene, 1987). Typical responses of marine mammals to small vessel noise are behavioral reactions, or no visible reaction, depending upon circumstances. Small vessel types used to hunt or harass marine mammals elicit greater responses than vessel types that don't engage in such activities (Richardson, 1995). Decibel levels produced by small vessels are usually insufficient to produce a TTS or PTS.

- **Large Vessels.** Large vessels (>85 m) are characterized by powerful engines with large, slow-turning propellers that produce low frequency sounds with high sound levels (Richardson, 1995). Radiated noise is mostly a function of vessel size, engine size, speed, load, and mode of operation. Usually large vessels are louder than smaller vessels with most of the noise levels produced at the lowest generated frequencies. Richardson (1995) noted source levels of large vessels and supertanker noise may exceed 205 dB re 1 μPa-m if components down to around 2 Hz are included. Although supertankers are not proposed in the Scenario, large vessel use would be an integral part of exploration and development, and the noise levels associated with their use could be similar to what Richardson (1995) used for supertankers. In order for higher decibel levels to affect any given marine mammal, those noise levels must occur within the audible frequency range of a particular species. Noises at 2 Hz and below lie below the audible range for most marine mammals and should have no effect on marine mammals near the noise; however, other noises above 5 Hz would probably be heard by some marine mammals. Such noise could produce avoidance reactions.
- **Icebreakers.** When an icebreaker is transiting open-water, the sound generated is less than when the vessel is managing or breaking ice. Icebreaking produces noise that tends to be louder and more variable than similar sized ships, up to at least 5 km from the noise source. The greatest sound generated during icebreaking operations is produced by cavitation of the propeller, such as the 5kHz noises the M/V *Robert Lemeur* produced when pushing on ice, as opposed to the

engine noise or the ice on the hull (Richardson, 1995). The typical duration of a single cavitation episode is about one minute. Davis and Malme (1997) noted cavitation occurs during icebreaking if a ship has to reverse and ram thick ice. Short (~5 sec) bursts of cavitation noise (197–205 dB) are created when the propeller is switched from astern (reverse) to full forward power, producing higher noise levels than continuous forward progress through the ice. Richardson (1995) noted a noise increase of 14 dB near the Supplier VII and 12-13 dB near the Robert Lemeur during icebreaking operations, although the increase in noise attenuated quickly under heavy sea ice. Icebreakers pushing ice radiate noise levels about 10-15 dB above what they produce when in open waters. Hall et al. (1994: as reported in Richardson, 1995) estimated the broadband (10-10,000 Hz) source levels to be 181-183, 184 and 174 dB re 1 µPa-m for the Kalvik, Ikaluk, and Canmar Supplier II, respectively, when breaking ice in the Beaufort Sea.

Aircraft Noise. According to Greene (1995), when the angle between the aircraft and the water surface exceeds 13 degrees from a noise receiver, much of the incident sound is reflected and does not penetrate into the water. Strong underwater sounds remain detectable so long as the aircraft is within a 26-degree cone from the noise receiver. This means that an aircraft usually can be heard in the air well before and after the brief period that it passes overhead and is heard underwater.

- **Helicopters.** Most helicopter use in support of Chukchi Sea OCS activities is for ferrying personnel and equipment to OCS operations, and involves turbine helicopters. Marine mammal mitigation helicopter flights are kept at a 1,500 foot altitude Above Ground Level (AGL) or Above Sea Level (ASL) unless safety requirements necessitate lower altitudes (NMFS, 2013b). According to Greene and Moore (1995:102-110), helicopters are capable of producing tones mostly in the 68 to 102 Hz range, at noise levels up to 151 dB re 1 µPa-m at the source. Additionally, they radiate more sound forward than backwards, which means noise levels would be audible at greater distances ahead of the aircraft than to its rear. Helicopter sounds measured underwater at depths of 3 and 18 m (9.8 and 59 ft) showed that sound consisted mainly of main-rotor tones ahead of the aircraft and tail-rotor sounds behind the aircraft; more sound pressure was received at 3 m (9.8 ft) than at 18 m (59 ft); and peak sound levels received underwater diminished with increasing aircraft altitude. Sound levels received underwater at 3 m (9.8 ft) from a Bell 212 flying overhead at 150 m (492 ft) ranged from 117-120 dB re 1 µPa in the 10-500-Hz band. Underwater sound levels at 18 m (59 ft) from a Bell 212 flying overhead at 150 m (492 ft) ranged from 112-116 dB re 1 µPa in the 10-500-Hz band.

  Helicopter noise is generally audible for only tens of seconds. Individual marine mammal responses appear to vary depending on flight altitude and received sound levels. Humpback whales in large groups showed little or no response, but some adult-only groups exhibited avoidance (Herman, 1980). Other species such as ringed and spotted seals and walruses have also shown noticeable flight reactions to helicopters (Born et al., 1999; Richardson, 1995; Burns and Harbo, 1972; Faye, 1982).

- **Fixed-Wing Aircraft.** Fixed wing operations typically assess marine mammal habitat use, distribution, and movement; they also monitor behavior before, during, and after seismic surveys and drilling operations occur. Monitoring surveys are typically conducted with aircraft flying above 1,500 ft AGL unless safety becomes an issue. Greene and Moore (1995:102-105) explained fixed wing aircraft typically used in offshore activities were capable of producing tones mostly in the 68 to 102 Hz range and at noise levels up to 162 dB re 1 µPa-m at the source. Though the noise levels of aircraft are insufficient to create physiological effects among marine mammals, it could produce behavioral responses that include avoidance, increased dive time, etc.

Drilling Noise. Drilling noise could discourage individual marine mammals from using habitat in the vicinity of drill sites, and concerns exist for such disturbances in feeding or migration areas. Drilling can be conducted from platforms or MODUs, which are mobile; these are either self-propelled, or towed from one site to another at speeds below 10 knots. Both platforms and MODUs generate continuous underwater noise from a stationary source.

Exploratory drilling would be conducted from MODUs.

Underwater sound propagation results from the use of generators, drilling machinery, and the rig itself. The level of sound propagation would depend upon a combination of factors including the rig characteristics, water depth, and location. Lower sound levels have been reported during well logging than during actual drilling operations (Greene, 1987) and underwater sound appeared to be lower at the bow and stern aspect compared to the beam (Greene, 1987).

During drilling operations, the MODU would produce low-frequency noises. Drill ships are louder than jack-up drilling rigs. Jack-up rigs lack a large hull area and have deck-mounted machinery, which means that sound from mobile platforms propagates through air and into sediments or ground layers rather than directly into the oceans, as is the case with drillships (Richardson, 1995).

Richardson (1995), numerous other studies, and three decades of marine mammal monitoring have shown that OCS drilling produces continuous noise that can lead to avoidance by marine mammals. Noise levels are normally too low frequency or too low in decibel level to produce physiological effects on marine mammals. Table 4-48 illustrates how a 6 mi (10 km) zone of noise exceeding 120 dB surrounds drillships, and a 0.6 mi (1 km) zone surrounds mobile platform drilling rigs. Only within such zones could a marine mammal experience noise exceeding the background noise that naturally occurs in the Chukchi Sea. This would result in harassment as devined by the MMPA and NMFS regulations.

Physical Presence

The effects of vessel presence on marine mammals are difficult to separate from the effects of vessel noise. Reactions to vessel noise may occur long distances from any actual vessel, while reactions not induced by sound could occur much closer to vessels. A number of variables determine whether a marine mammals is likely to be disturbed by vessels, including the ambient noise level, wind direction, the number of vessels, distance between a vessel and a marine mammal, vessel speed and direction, vessel noise, vessel type or size, habituation, threat association, and activity of the marine mammal. Vessel operations can occur throughout the Leased Area to conduct surveys in the vicinity of leases. Such vessels mostly operate from July to November, and produce effects through visual presence, exhaust emissions, traffic frequency, and vessel speed, and (in the case of icebreakers), ice displacement. Marine mammal species may be exposed to vessels when seasonal distribution and habitat selection overlaps in time and space with proposed exploration vessel activities.

Vessels are used in a variety of ways in OCS oil and gas exploration operations, such as transportation, icebreaking/ice-management, construction, monitoring, refueling, storage, and as seismic survey vessels, etc. All in-ice seismic surveys, and some late fall/early winter exploration drilling, may require icebreaker operations.

Small Vessels. Schevill (1968) found motorboats that are mostly silenced had greater success than un-silenced boats moving among cetaceans without producing reactions.

Richardson (1995) cited studies from Salter (1979) and Fay (1981) in which walruses showed no detectable response to motorboats unless approached too closely, despite the noise from operating outboard engines. Walruses respond to the odor of the exhaust and other smells from the vessels and may be approached more closely from downwind, but will flush rapidly when approached upwind.

Polar bear reactions to vessels are variable, depending upon the bear and the situation. They may react to small vessels by fleeing, or they may approach vessels. Females with cubs are more likely to be wary and avoid vessels. All polar bears are less likely to flee while engaged in eating or resting at a carcass. Most vessels would be in open water and are unlikely to encounter polar bears. Only vessels operating near barrier islands, in sea ice, or near the ice edge are likely to have interactions with polar bears, which generally show tolerance to vessels.

The responses of mysticetes are mixed. They show a great deal of tolerance to vessels that are stationary or distant, and strong avoidance of moving vessels.

The responses of odontocete whales differed from that of mysticetes in that many toothed whales do not avoid vessels if they do not recognize vessels as threats, and often approach vessels. However, some species, such as belugas, may display strong avoidance reactions to vessels, particularly if they are a hunted population (Richardson, 1995).

Large Vessels. Richardson (1995) observed that pinnipeds in Alaska easily habituate to the presence of large vessels unless approached to within approximately 200 m (656 ft).

Resting walrus are acutely sensitive to smells and may be closely approached by large vessels if they are downwind, but will flush if the vessel is upwind at a much greater distance.

Polar bears and large mysticete whales tolerate large vessels unless those vessels directly approach them (Richardson, 1995), in which case they often attempt to escape. Mysticete whales have long lifespans; bowheads in the western Arctic were commercially hunted until the 1960s and may associate large vessels with whaling. In comparison, ondontocetes such as killer whales regularly approach vessels of all size classes, and some dolphin and porpoise species seem to enjoy “riding” in the bow waves of passing vessels. Beluga reactions to vessels are mixed and may vary with location. Some belugas in the Gulf of St. Lawrence seasonally habituate to boats, while others in Arctic Canada show strong escape reactions from vessels and icebreaking (Richardson, 1995). Polacheck and Thorpe (1990) noted harbor porpoises tended to swim away from approaching vessels, while Evans et al. (1994) found varying harbor porpoises responses according to vessel size and behavior.

Icebreaking. In 2010, BOEM supported a literature review and analysis examining the potential for icebreaking to affect ice habitat or alter the mechanical behavior of the surrounding ice (Mahoney et al., 2012). This review and analysis suggested that during icebreaker activity in fall/winter, when temperatures are below freezing, in many cases track lines would refreeze within a matter of several hours. Icebreakers create new leads or widen existing leads in the sea ice, though these effects are overshadowed by the natural variation in land fast ice, which is constantly re-breaking, and even more so in pack ice. In spring when the ice is melting and retreating further north, icebreaking could lead to faster break up of existing sea ice. Leads that were created by icebreakers would remain and widen as long as temperatures remained near or above freezing. Any icebreaking activity in spring/summer could open new leads, which could remain open and expand as the open water absorbs more light. The most noticeable effect of icebreaking on marine mammals in areas of largely consolidated pack ice would be to create new leads. These could temporarily provide greater water access for pinnipeds and polar bears, but they would also quickly refreeze, lessening their habitat value to marine mammals. Shifting ice pushed by icebreakers in late fall or early spring could damage ringed seal or polar bear dens, or under certain circumstances, trap whales or crush marine mammals. Springtime icebreaking activity could hasten sea ice breakup by creating smaller, faster-melting ice floes. This could reduce the amount of sea ice available for resting for ice seals during spring molting and for walrus, including females with calves. Walrus calves are not able to withstand the cold water for the same length of time as an adult walrus. Tagging studies have identified the Hanna Shoal area as an important feeding area for walrus, and have shown that walrus, including females with calves, will remain as close to this area as possible until there is no longer any sea ice to haul out on (Jay, Fischbach, and Kochnev, 2012).

Vessel Strikes. Large vessels employed for oil and gas exploration activities range from 75 m (246 ft) to ≥110 m (≥361 ft) in length. For the purpose of this analysis, MODUs are considered large vessels as well.

Vessel speeds range from 4.5 knots when towing seismic gear up to 16.5 knots when transiting. Seismic operations in the Scenario would take place during the open-water period. Vessel activity would be 24 hours a day, including periods of poor visibility due to darkness and weather conditions. Laist et al. (2001) noted that 89% of all whale collisions in which a vessel killed or severely injured a whale occurred with vessels moving at 14 knots or greater. No collisions occurred at speeds of less than 10 knots. Collision records first appear late in the 1800s when the fastest vessels began attaining speeds of 14 knots, and then increased sharply in the 1950s-1970s when the average speed of most merchant ships began to exceed about 15 knots. Large vessels in the Arctic region typically operate at less than 10 knots when traveling from location to location, such as when positioning at a drill site. These large vessels cannot perform abrupt turns and cannot slow down quickly over short distances to react to encounters with marine mammals. Effects on large whales are dependent upon the interaction of visual presence; timing, duration, and frequency of trips to work locations; routing, and seasonal and concurrent numbers of large vessels operating in a region; and spatial/temporal overlap with the seasonal distribution, including critical life function habitats (breeding, calving, nursing, feeding, migrating, resting areas etc.) of large whales.

Small vessels are used to support refueling operations and equipment/personnel transport. These vessels are <75 m (246 ft) long and can make rapid turns and slow down in relatively short distances to avoid collisions with marine mammals. These vessels may operate at speeds greater than 10 knots during supply missions and operate in periods of darkness and poor visibility, which does increase the chance of a collision with a marine mammal. Marine mammals may also be injured by propeller strikes. These injuries occur most often in close quarters (for example, when operating in broken ice with marine mammals nearby) and during quick turns and backing. Propeller strikes can result in "corkscrew injuries" such as have occurred in recent years among seals in the North Atlantic, and other propeller-inflicted injuries which have occurred with walrus, seals, and small whales, may lead to mortalities of marine mammals.

Aircraft Presence. Aircraft traffic in support of Chukchi Sea OCS activities includes helicopter flights for personnel transport and fixed-wing aircraft engaged in monitoring activities.

- **Flight Paths.** Aircraft flying below 500 ft (152 m) have a much greater likelihood of startling or affecting marine mammals. Similarly, aircraft flying over groups of marine mammals are much more likely to elicit startle responses than those that fly over individuals. Hauled out spotted seals have been known to respond to low-flying approaching helicopters from distances up to ¼ mi (402 m) or greater, and walruses have been known to startle and flee from aircraft approaching below 1,000 ft (305 m) (Richardson, 1995). Pinnipeds on ice or on land are likely to show greater responses to aircraft traffic than those in the water. Most cetacean species have exhibited responses to low-flying aircraft by diving deeper, or for longer times. With species such as bowhead whales much of the responsiveness of individuals to passing aircraft are a function of aircraft and animal activities, noise production, and time of year.
- **Flight Frequency.** Pinnipeds could be expected to partially habituate to frequent aircraft flights, though at some level of flight frequency seals could come to respond more frequently or strongly to the disturbance (Richardson, 1995). It is likely cetaceans would exhibit behavioral responses similar to those of pinnipeds. Consequently, marine mammals should habituate to increased flight frequency unless the frequency of flights passes some threshold resulting in higher levels of responsiveness to aircraft flights. Flights during winter and early spring should mostly affect polar bears and ringed and bearded seals. Those flights occurring in the late spring and open-

water season have the potential to impact all species of marine mammals found in and around the Leased Area.

Discharges

The principal regulatory method for controlling pollutant discharges from vessels (graywater, black water, coolant, bilge water, ballast, deck wash, etc.) into waters of the Chukchi Sea OCS is Section 402 of the CWA of 1972, which established the NPDES permitting system. The EPA regulates the discharge of drilling muds (used to lubricate drill bits), cuttings (material removed from drill holes), and other materials to the marine environment. The Chuckchi Sea exploration NPDES general permit (AKG-28-8100) for oil and gas exploration facilities on the OCS is currently in effect. Vessels greater than 79 feet in length operating as a means of transportation in the territorial seas would require NPDES permit coverage for their incidental discharges under the Vessel General Permit (VGP). Vessels less than 79 feet in length that are operating as a mean of transportation may be covered under the VGP, or may instead opt for coverage under the Small VGP issued by EPA. These permits establish effluent limitations to control materials that contain constituents in the waste streams resulting from the activities of these vessels. Pollutant constituents in the VGPs may include nutrients, pathogens, oil and grease, metals, biochemical oxygen demand, pH, total suspended solids, aquatic nuisance species, and other toxic and non-conventional pollutants with toxic effects. In addition to complying with NPDES requirments, vessels discharging in the contiguous zone and ocean (seaward of the outer limit of the territorial seas) are subject to the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78), implemented by the U.S. Coast Guard pursuant to 33 CFR Part 151).

The EPA regulations at 40 CFR 125.122 require a determination that the permitted discharge will not cause unreasonable degradation to the marine environment.

Discharge of Muds and Cuttings. Drill cuttings released at drilling sites would fan out and disperse downstream from the point of release. Over time these cuttings would form a layer on the sea floor that could kill many benthic invertebrates. The loss of benthic invertebrates on the sea floor could remove a limited area of the sea floor from available foraging habitat for bearded seal, Pacific walrus, gray whale, and bowhead whale. For example, a previous drilling operation on the Burger prospect is estimated to have disturbed 1,018 ft^2 of seafloor per well and each well cellar excavated 619 yd^3 of sediment. Cuttings from the well cellar excavation were deposited on the seafloor below the temperature and salinity stratification layer. It is estimated that the maximum thickness of the sediment deposition onto the seafloor would be 10.4 ft (3.2 m) and the deposition would continue out to a horizontal distance of 449 ft (137 m) from the excavation site, where it would be 0.4 in (1 cm) thick. The excavation of a mud line cellar in a season would increase sediment, suspended solids, and turbidity in the lower water column above background levels, dependent upon the mineralogy and grain size of the sediments excavated. Currents and severe storm events could re-suspend and transport these newly deposited seafloor sediments (USDOI, BOEMRE, 2011g). In addition to the temporary loss of benthic prey, forage fish prey species could also be affected by the turbidity and sediments in the water column. Turbidity could affect the prey species and possibly the ability of marine mammals to locate prey in the immediate area of the drilling. After the deposition of materials from the disturbance of benthic surfaces ceases, it could take 4-8 years for the sea floor to return to a state where it is biologically usable for marine mammals, depending on the amount of material and deposition rate.

The ensuing downstream plume from cuttings dispersed into water is normally 10s of meters wide and 100-900 m (328-2,953 ft) long. It is unlikely that marine mammals would be able to hunt effectively in these plumes, and reduced hunting success could drive animals out of the affected area. In spite of this, marine mammals remaining in the affected area should not experience any effects from inhalation, since they surface to breathe air. Disposal of drilling muds and cuttings would be as specified under conditions prescribed by the EPA's NPDES permit. Discharge of drilling muds and cuttings during exploration activities is unlikely to have measurable effect on marine mammals, either directly through contact or indirectly by affecting prey species. Effects would be restricted primarily to the immediate area around drilling since drilling muds and cuttings rapidly dilute or settle in water. The potential benthic habitat affected would be insignificant relative to the total benthic habitat in the Leased Area.

Discharge of drilling muds and cuttings during exploration activities should not cause population-level effects to any marine mammals, either directly through contact or indirectly by affecting prey species. Any effects would be localized primarily around the drilling unit because of the rapid dilution/deposition of these materials.

Discharge of Graywater. Graywater is used water from galleys, baths and showers, sinks, laundry, water fountains, and dishwashers EPA (2011a). Wastewater can be associated with the release of pathogens and byproducts that are hazardous to marine life. EPA and USCG regulate wastewater releases into the Chukchi Sea and require operators to obtain permits for discharging graywater. Graywater would be discharged through a caisson at less than 10 m (33 ft) below the water surface, where it would mix with surface waters when on the drill site. Discharges are regulated through NPDES general permits, and required to meet Federal and state standards for protection of water quality and the marine environment. Although it is illegal, the discharge of oily sludge, garbage, and other debris from commercial vessel traffic could pose significant risks to ringed seals because these types of pollution are more common and widespread than accidents. These types of discharges could have immediate and long-term impacts on individuals, communities, and the environment (Arctic Council, 2009) and could include disease, infection, or ingestion of low levels of toxins.

Accidental Oil Spills

Small refined oil spills could occur during the Exploration phase, in conjunction with geological and geophysical surveys or exploration drilling. Section 4.1.2.5 and Tables 4-1 and 4-2 describe the assumptions concerning small oil spills. Small refined spills could occur during the open-water season. Small spills are ≤50 bbl. Table A.1-24 and 25 show that small spills would evaporate and disperse within 3 days or less during summer, and most have little (<0.5%) chance of contacting GLSs (Table A.2-37). Because small refined offshore oil spills dissipate rapidly they would have negligible to minor effects on marine mammals.

Two large oil, condensate, or gas releases are anticipated in the Scenario. One large spill is a 5,100 bbl release from a production platform, and the other is a1,700 bbl spill from a pipeline. Because of the weathering characteristics of crude oil, condensate, and gas, the effects of these accidental releases; and the spill characteristics such as size, location, currents, rate at which materials are released, etc., there should be no lingering, chronic, or cumulative effects from these spill events.

Development and Production

Noise

Platform Construction. The results of acoustical studies at the island-based Northstar production facility indicate underwater sounds attenuate rapidly and reach background levels within a few km of the sound source (Blackwell and Greene, 2001, 2006). Thomson and Johnson (1996) investigated the effects of construction activities and noise from the Molikpack and PAB on marine mammals off Sakhalin Island in the North Pacific Ocean. Construction activities included blasting to densify the berm, suction dredging, berm construction, armoring the berm with rock, positioning the Molikpaq on the berm and filling it with solid ballast, trenching pipelines, riser installation, Single Anchor Leg Mooring (SALM) bouy installation at the pipeline terminus, and mooring a storage tanker to the SALM and connecting it to the riser. Similar activities are expected for production platform construction, though the soft substrate in the Chukchi Sea suggest pile driving, rather than berm construction, would be used to anchor production platforms into the seabed.

Pile Driving. Pile driving is a technique that could be used to fix production platforms to the sea floor in the Leased Area. Green et al. (1995) reviewed the topic of pile driving noise production in the marine environment, noting noise levels of 131-135 dB re 1 μPa from pile driving near Prudhoe Bay, Alaska. More recently Blackwell (2005) recorded pile-driving noises of 190 dB re 1 μPa across a 100 Hz – 2 kHz frequency range from pile driving activities at the Port MacKenzie docks in upper Cook Inlet, Alaska, in 2004. Typically the decibel levels from the Port MacKenzie dock modification work dropped to ambient levels (115-133 dB re 1 μPa) within about 1 km from the noise source. The low-frequency, percussive noise produced by pile driving would be detectable to marine mammals several km from the activity. However, the decibel levels would remain insufficient to elicit any physiological responses among marine mammals in or near the Leased Area. Marine mammals would likely have behavioral responses to such noises such as avoidance or skittishness. Miles et al. (1987) detected hammering sounds of 131-135 dB re 1 μPa, at 40 – 100 Hz, extending to 1 km from conductor pipe installation activities at the Sandpiper 1 island in Prudhoe Bay, Alaska. Moore et al. (1984) recorded noise levels 25-35 dB above ambient levels in the 50 – 200 Hz frequency range.

Other Construction Noises (dredging, pipeline installation, etc.). Richardson (1995) noted that dredges, which can be used to create artificial islands, to deepen channels, and for general offshore construction activities, can be major sources of underwater noise in some nearshore regions. Greene and Moore (1995) also found that dredges can be strong sources of continuous noise in nearshore regions, and that the noise they produce is strongest at low frequencies. This continuous noise may be audible for distances ≥25 km in nearshore areas. In past surveys, the interactions of beluga whales, bowhead whales, and dredge noise was observed; some slight aversion was observed in some bowhead whale responses, while belugas showed greater reactions to large ships. Moreover, other bowhead whales did not modify their behavior in areas where actual dredging occurred, which indicates that some level of habituation to dredge noise may develop among cetaceans. Bryant et al. (1984: as cited in Richardson, 1995) found wintering gray whales avoided a lagoon in Baja California for several years when dredging activities were occurring. Decibel levels up to 30 dB above ambient noise levels were detected by Richardson, Würsig, and Greene (1990) during a related study in the Beaufort Sea, and henceforth the assumption will be that dredging produces low-frequency noise and decibel levels approximately 30 dB above the ambient noise levels in the Leased Area. Dredging noises are strongest at lower frequencies and are not typically detectable within 20-25 km of the source due to the rapid attenuation of low frequencies in water.

Richardson (1995) summarized information relating to platform construction noises, concluding that marine mammals generally do not avoid equipment operating on small islands or platforms, and under some conditions certain species may even become curious and investigate such activities.

Construction/Decommissioning Activity

Construction and decommissioning activities should have limited effects on marine mammals in the Leased Area. The primary source of disturbance from these activities would be the noise produced by pile driving, trenching, platform assembly, and laying in pipelines. Smaller disturbances include construction of mud-lined cellars, caissons, anchor placement, etc., which would result in benthic foraging habitat loss in the immediate platform area until after decommissioning.

Anchoring, caisson construction, and mud-lined cellar construction would produce a small, temporary seafloor footprint that could result in the loss of foraging habitat. After decommissioning, the area would be re-colonized by benthic invertebrates and fishes. The period of time it would take for re-colonization to occur would depend upon the size of the disturbed area and other factors.

Production

Accidental Small and Large Oil Spills

Small oil spills. Small refined oil spills could occur during the development phase, in conjunction with construction activities, and drilling. Section 4.1.2.5 and Tables 4-1 and 4-2 describe the assumptions concerning small oil spills. Small refined spills could occur during the open-water season. Small spills are ≤50 bbl. Table A.1- 24 and 25 show small spills would evaporate and disperse within 3 days or less during summer, and most have little (<0.5%) chance of contacting GLSs (Table A.2-37). Because small refined OCS oil spills dissipate rapidly they would have negligible to minor effects on marine mammals.

Large Oil Spills. Large oil spills are unauthorized events. Spill prevention and oil-spill response plans, including in-place equipment, personnel and infrastructure, are required for all operations (30 CFR 254). Marine mammal species could be affected depending on the location, timing, duration, sea and climatic conditions, and response to spill events. Oil spill events occurring during the late summer could overwinter and result in contact with polynyas the following spring though weathering would decrease the volatility and toxicity of the spilled oil.

Potential physiological effects that could lead to reduced marine mammal fitness include:

- Irritation, inflammation, or necrosis of skin; chemical burns of skin, eyes, mucous membranes; inhalation of toxic fumes with potential short- and long-term respiratory effects (e.g., inflammation, pulmonary emphysema, infection).
- Partial or extensive coating of pelts with oil for polar bears would reduce insulation and could result in hypothermia and ingestion of oil during grooming; either could result in mortalities.
- Ingestion of oil (and dispersants) directly or via contaminated prey, leading to inflammation, ulcers, bleeding, damage to liver, kidney, and brain tissues. Disturbance from beach cleanup crews, vessels and aircraft during spill response and cleanup.
- Oil coating baleen in mysticetes whales which could adversely affect baleen functionality in sieving food from sea water.

Complications of the above may lead to reduced fitness, injury and mortalities. Determining mortality rates for marine mammals, particularly for cetaceans, during an oil spill can be difficult. For example, not all animals found dead necessarily died from exposure to oil. Gray whales found after the 1969 Santa Barbara spill were initially thought to have died from the spill, but that conclusion was reversed after examination of the whales found no linkage to the spill. Similarly, the large number of dead, stranded gray whales observed after the Exxon Valdez Oil Spill could not be linked to the spill, and the increased observations of strandings were attributed, at least in part, to the increased search effort associated with the spill. Also during the Exxon Valdez Oil Spill, a resident pod of killer whales was observed swimming through the spilled oil. This pod subsequently disappeared and was eventually presumed to have died as a result of the spill, though no carcasses were recovered. Many carcasses sink after death and cannot be recovered, making effects determinations problemmatic. In addition to short term mortalities, sublethal impacts may affect individual fitness, reproduction, prey availability and behavior.

Shipping activities carry the risk of accidental or illegal releases of toxic substances, which, due to their immediate and potentially long-term effects on individual animals, populations, food webs, and the environment, could impact marine mammals (Arctic Council, 2009). There is a lack of accident response resources in the Arctic as well as a lack of effective techniques for containing or cleaning up spilled oil under ice or in broken ice. There are also challenges of associated with conducting a rapid, effective spill response in a region where weather is often severe, daylight may be limited, and accidents may happen in remote locations (AMAP, 2007).

Oil-Spill Response and Cleanup. Cleanup activities following an oil spill could involve multiple marine vessels operating in the spill area for extended periods of time. As explained in the discussion of impacts associated with vessel traffic, cetaceans and pinnipeds may react to the approach of vessels with avoidance behavior, and the potential for vessel collisions with marine mammals could increase. Vessels would typically be responding to surface oil, whales, walrus and ice seals may be displaced from oiled areas, reducing the potential for contact. In oiled feeding areas, whales, walrus and ice seals would have a reduced potential for fouling baleen or ingesting oiled prey as long as the vessels were present. If a spill occurred in an area near the ice edge or where pack ice was present, polar bears could also be impacted.

After a large oil spill, helicopter and fixed-wing aircraft overflights would typically be used to track the spill and to monitor distributions of marine wildlife. This monitoring helps guide response, and efforts are made to prevent oil from contacting important animal concentrations or concentration areas. As explained in the discussion of impacts associated with aircraft traffic, the impacts to marine mammals from aircraft encounters are transient and animals will typically resume normal activities within minutes.

Oil-spill-cleanup activities could increase disturbance effects on whales, polar bears or pinnipeds, causing temporary disruption and, possibly, displacement. In the event of a large oil spill contacting and extensively oiling coastal or ice-covered habitats, the presence of response staff, equipment, and aircraft involved in the cleanup could (depending on the time of the spill and the cleanup) potentially displace whales, walrus, polar bears and ice seals. If extensive cleanup operations occur in the spring, it could cause increased stress and reduced pup/calf survival of ringed seals/walrus. Oil-spill-cleanup activity could exacerbate and increase disturbance effects on prey species, cause localized displacement of prey species, and alter or reduce availability. The displacement of marine mammals away from oil-contaminated areas by cleanup activities, however, could reduce the likelihood of direct contact with oil.

Natural Gas Releases

Most gas escaping and contacting water would dissipate quickly, resulting in no effect on marine mammals. Any marine mammals in the vicinity of a large natural gas release could be exposed to toxins and potentially die before the gas could volatize. The species most likely to be affected would be ringed seals and bearded seals due to their estimated population sizes, broad distribution across the Chukchi Sea, foraging habits, expected habituation to pipelines and platforms, and year-round presence in the area. If a large gas release occurred, and if seals were present at the time, no more than a few dozen should be affected at most before the gas could dissipate into the atmosphere.

Impacts of the Scenario through Time

The first part of this section summarizes key oil and gas activities associated with each of the five periods of the Scenario and how those activities would sequentially unfold, and identifies general impacts common among marine mammal species, and generally identifies some of the more notable impacts to individual species. The second part of this section analyzes how these activities would collectively affect each marine mammal species.

Exploration (Years 1-5)

During the exploration phase of the Scenario, aircraft traffic would be used to support exploration and delineation drilling, but is not expected for support of marine seismic or ancillary surveys. Vessel traffic would also occur but only in support of seismic surveys, exploratory drilling, and ancillary activities. The standard suite of required NMFS mitigations, including the presence of PSOs onboard vessels should prevent vessel strikes to marine mammals. Exploration drilling would require flights on a more regular basis for resupply and crew changes. In the Scenario, a marine seismic survey would occur in Year 1, followed by 12 exploration wells which would be drilled in Years 3-5, using two MODUs.

Concurrent with the seismic survey and exploratory drilling, geohazard and geophysical surveys could occur in Years 1, 2, and 5. Along with such activities come increasing levels of aircraft and vessel use. All projects in the Exploration phase of the Scenario could require air and vessel support.

With no anticipated overlap between years of marine seismic exploration and exploration drilling in the first five years of the exploration phase of the Scenario, the impacts in any given year would mostly be restricted to continuous or pulsed noise. Different geohazard and geotechnical surveys would likely overlap with the seismic exploration of Year 1 and the exploratory drilling in Years 3-5; however, the small footprint of effects from these surveys would not add appreciably to the affected soundscape in the Leased Area. Likewise, the additional vessel would not add appreciably to other potential levels of effect within the Leased Area. The synergistic effects of the relevant IPFs to marine mammals during Years 1-5 of the Scenario would be negligible due to the localized area of effects for most IPFs. The exception could be seismic surveys which are detectable up to 120 km (75 mi) from the source or further, depending on water depth, temperature, salinity and other conditions (Table 4-48). However, previous experience based on environmental information collected during Arctic marine seismic surveys and other studies has demonstrated little or no impact, i.e., negligible to minor impacts to marine mammals (Brueggeman, 2010; Brueggeman et al., 1992, 2009; Clarke et al., 2011, 2012, 2013, 2014; Delarue et al., 2012, 2013; Funk et al., 2008, 2010; Bisson et al., 2013; Blees, Hartin, and Ireland, 2010).

Accidental Oil Spills

Small refined oil spills could occur during the Exploration phase, in conjunction with geological and geophysical surveys or exploration drilling. Section 4.1.2.5 and Tables 4-1 and 4-2 describe the assumptions concerning small oil spills. Small refined spills could occur during the open-water season. Small spills are 50 bbl or less and Table A.1- 24 and 25 show small spills would evaporate and disperse within 3 days or less during summer, and most have little (<0.5%) chance of contacting ERAs (Table A.2-25). Since weathering process would quickly dissipate refined oil to harmless residual levels, and because small spills are very unlikely to contact marine mammal ERAs within three days, small refined oil spills should have little or no impact, i.e., negligible impacts, on marine mammals.

Exploration and Development (Years 6-9)

Exploratory drilling would continue in Years 6-9 with a maximum of four wells drilled per season from two drilling rigs. Concurrent with the exploratory drilling would be a marine seismic survey in Year 8; one geohazard survey in Years 6 and 7, and one geotechnical survey in Years 6 and 7. In addition, development activities would commence, and 40 miles/year of offshore oil pipelines would be laid into the sea bed in Years 6-9, using dredges, for a total of 160 miles of oil pipeline. Vessel and aircraft use during this phase of the Scenario would approximate that of the first five years of Exploration phase with 13 projects requiring support, plus any air or watercraft needed to support pipeline construction on the OCS. Dredging trenches for pipeline placement would require dredges, and a vessel to lay the pipeline in behind the dredge. Dredges would act as a mobile continuous loud noise source, and pipeline construction would likely use more than one dredge annually.

The additive and synergistic effects of routine oil and gas activities during the Exploration and Development phase would be similar to those described for Years 1-5. However, pipeline installation would add new sound and vessel presence issues to the environment in the Leased Area and between the Leased Area and Wainwright, Alaska. Dredging noise could affect marine mammals between an Anchor Field and shore, but effects would vary with marine mammal species and species location, which are affected by timing, fluctuating resource conditions, and seasonality, as well as the actual location of of the pipeline. A large crude or condensate spill is not considered to be a component of routine oil and gas activities but could occur during Development. If a large spill occurred during the Exploration and Development phase, the effects of both the spill and the overall phase would vary with species, species location, and spill location. Detailed analyses of large oil spill impacts by species are presented later in Section 4.3.7.1.

Accidental Oil Spills

Small Oil Spills

Small refined oil spills have the potential to occur during the Exploration and Development phase of the Scenario in conjunction with geological and geophysical surveys, exploration drilling, and initial development activities such as facility construction and pipeline installations. Spill characteristics and effects would be consistent with those described for small oil spills in the Exploration phase. Consequently, impacts from this phase are expected to be negligible.

Large Oil Spills

Large (≥1,000 bbl) crude or condensate oil spills could occur during Development activities. The analysis of potential impacts to marine mammals and important habitat areas from a large oil spill are discussed in detail in *Exploration, Development, and Production (Years 10-25*), below, and in *Effects by Species*, later in Section 4.3.7.1.

Exploration, Development, and Production (Years 10-25)

During this period, Exploration, Development, and Production activities would proceed concurrently. Marine seismic surveys would occur during Years 15, 19 and 25; exploration wells would be drilled via four drilling rigs in Years 20-22; and production platforms would be constructed in Years 10, 13, 16, 19, 22, and 24. Furthermore, production wells would be drilled from production platforms in Years 10-25, peaking at 32 wells drilled in Year 25. Note however, that not all platforms would be drilling simultaneously. Thirty two wells from 8 platforms averages 4 wells per platform in Year 25 during the peak of drilling. The noise footprint from this level of drilling would still equate to a 1.4 km (0.9 mi) zone surrounding each production platform where manmade noise might exceed the ambient noise levels for the ocean, mostly at 20 Hz. Similarly, numerous subsea wells would be drilled from mobile platforms in Years 12-24, and linked to production platforms with 5 mi (8 km) pipelines in Years 13, 16, 19, and 22. In Year 24, a 20 mi (32 km) oil pipeline would be constructed to link Satellite Field A-2 production platform, also built in Year 24, with the Anchor Field. Throughout this 16-year period, numerous aircraft and vessels would be required to support at least 64 different operations and would include helicopters, large and small vessels, seismic vessels, barges, dredges, coring vessels, and four MODUs. Geohazard and Geotechnical surveys would also be conducted in Years 11, 14, 17, 19, 20 and 23, and pile driving would also occur periodically between Years 10 and 24 to anchor production platforms (Figure 4-2).

Drilling noise from jack-up rigs, used in this analysis as a proxy for noise from production platforms, is much less noisy than is observed with drillships. This reduces the noise footprint of exploratory drilling, to an affected area having a diameter of 1.2 mi (2 km) for each operating drill. Assuming one drill would operate from each platform, drilling from all production platforms could ensonify six 1.2 mi (2 km) diameter areas at most before noise returned to background levels. If more than one drill were to be used on each platform, the affected area should not appreciably increase in size, affected bandwidth, or volume, since the drills would be operating in very close proximity, and noise levels from each drill should be similar, as should the frequencies.

Accidental Oil Spills

Small Refined Oil Spills. Small refined oil spills have the potential to occur during the Exploration, Development, and Production phase of the Scenario in conjunction with geological and geophysical surveys, exploration drilling, and initial development activities such as facility construction and pipeline installations. Spill characteristics and effects would be consistent with those described for small oil spills in the Exploration phase.

Small Crude Oil Spills. Section 4.1.2.5 and Tables 4-1 and 4-2 describe the assumptions concerning small crude oil spills. Small refined oil-spill impacts would be consistent with what was described for Exploration, and for Exploration and Development. Small crude oil spills normally persist for a longer period than refined oil spills, and small condensate spills persist for a shorter period than small refined oil spills. Low-volume spills are considered likely under the Scenario. In addition to the refined small spills analyzed in Exploration (Years 1-22), small crude and condensate spills could occur. The largest number of small crude and condensate spills would likely occur during development and production. Up to 520 small crude oil or condensate spills are estimated, annually 0–12 spills could occur, totaling up to 36 bbl (Tables 4-1 and 4-2). Crude or Condensate spills up to 3 bbl are expected to evaporate and disperse within 3 days, and spills <1 bbl should evaporate and disperse within 10 hours. More in-depth information on small oil-spill characteristics is found in Section 4.1.2.5.

Large Oil Spills

Section 4.1.2.5 and Table 4-3 describe the assumptions for a large oil spill(s). The OSRA model estimates conditional probabilities (expressed as a percent chance) of a large spill contacting certain areas (ERAs, Table A.1-11). The following discussion summarizes LAs and PLs annually, unless otherwise specified. The following paragraphs present the results (expressed as a percent chance) estimated by the OSRA model, for values from any LA or PL ≥5%, of a large spill contacting habitats important to marine mammals.

Cetaceans. In this analysis, large oil spill contact less than 5% would likely be too small, widely dispersed and weathered to produce appreciable impacts on cetaceans based on the spill assumptions in Table 4-3. The dispersal and weathering of large oil spills in Table 4-3 should be interpreted to marine mammal ERA, meaning the effects of such mean only a portion of a large condensate, refined, or crude oil spill would be capable of contacting a a spill would be much less than would otherwise be expected if the entire contents of a large spill were to contact that same ERA. The chance of contact with specific ERAs important to marine mammals are analyzed below as they apply to each species of marine mammal, and the specific effects analyses of oil spills on marine mammal species are analyzed in Effects by Species towards the end of this discussion.

Cetacean ERAs

The following paragraphs present the results (expressed as a percent chance) estimated by the OSRA model, for values ≥5%, of a large spill contacting habitats important to cetaceans, and only values ≥5% are analyzed in the following paragraphs. The OSRA model estimates that the chance of a large spill from any offshore ERA important to cetaceans (Table A.1-11) ranges from 5-22% for any individual LA and from 5-36% for any individual PL for values > 5% within 30 days (Table A.2-3); for 360 days, that chance ranges from 5-24% from any individula LA and from 5-37% from any individual PL (Table A.2-6), depending on the distance between LAs/PLs and ERAs (Maps A.5 and A.1-2a through f).

The highest chance of contact from any individual LA and PL (24-37%) is to ERA 61 (Bowhead and Gray Whale Summer Fall Feeding) within 30 and 360 days, respectively (Tables A.2-3 and 6). The chance of contact to this area is highest because the OSRA model's LA s or PLs and the resource area are directly adjacent this ERA (Appendix A, Map A-2b).

For beluga whales the percent chance for values ≥5%, that a large oil spill would contact Kasegaluk Lagoon (ERA 1) is 9%, from PL6 within 30 days and 360 days. The chance that a large oil spill would contact the Herald Shoal polynya (ERA 62) is 5-11% (LAs 4, 5, 6, 11, PLs 2, 6) and 5-12%

(any LA or PL) within 30 and 360 days, respectively. The chance of a large oil spill contacting AK BFT Outer Shelf and Slope 10 (ERA 119) from LA 11 or PLs 8 and 9 is 6-9% within 30 days, and 5-10% from any LA or PL except LA1within 360 days, respectively.

Bowhead whales in the process of calving and accompanied by newborn calves are somewhat confined to the Chukchi Sea spring lead system (ERA 49, 53, and 54) during the spring migration period (April-June). The chance of a large spill contacting ERAs (53, 54) is 6-14% from LAs 10 or 11 within 30 days (Table A.2-3). Similarly, the OSRA model estimates a large spill from PLs 3, 5, or 8 has a 5-22% chance of contacting bowhead whales using ERA 49, 53 and 54 within 30 days (Table A.2-3). The chance of a large spill contacting these ERA is 5-14% from LAs 10 or 11 and 5-23% from any PL except PL1 within 360 days (Table A.2-6). Bowheads continue the spring migration into the Beaufort spring lead system (ERAs 30-37 and 45). The OSRA model estimates the chance of contact to these ERAs is<5% from all LAs and PLs within 30 or 360 days (Table A.2-3 and 6). The chance that a large oil spill would contact ERA 123 (Alaska Chukchi Sea Offshore) from LAs 1, 4, 5, or 6, or PLs 5 and 8 is 5-9% within 30 days and 360 days. The chance that a large oil spill would contact ERA 124 (Central Chukchi Sea Offshore) from all LAs 4 and 5, and PLs 2 and 5, is 5-7% within 30 days and 360 days.

Hanna Shoal (ERA 56) was identified as important to bowhead and gray whale feeding. The chance that a large oil spill would contact Hanna Shoal (ERA 56) is 5-21% (LAs 1, 6, 11, PLs 5, 8, 9) and 5-24% (any individual LA or PL, except PL3) within 30 days and 360 days, respectively (Table A.2-3). Within 30 and 360 days PL 3, and within 30 days LAs 4 and 10, and PLs 2 and 6 has <5% contact to ERA 56. The OSRA model estimates that fall migration and potential feeding concentration ERAs 21-29 have a <5% chance of contact from LAs and PLs within 30 and 360 days (Table A.2-3 and 6).

Gray whales primarily use coastal habitat and some spring lead systems, which is where most of the gray whale ERAs are located. At one time their presence in the vicinity of Hanna Shoal was notable, but in recent decades they appear to have shifted to more coastal areas, particularly the Peard Bay Area. ERAs important to Gray Whales include Chukchi Sea Spring Lead 1 (ERA 49), Chukchi Sea Spring Lead 2 (ERA 53), Chukchi Sea Spring Lead 3 (ERA 54), Hanna Shoal Area (ERA 56), N Chukotka Nearshore 2 (ERA 82), N Chukotka Nearshore 3 (ERA 83), Pt Hope Offshore (ERA 107), Barrow Feeding Aggregation (ERA 108), RUS CH GW Fall 1 (ERA 120), and C Lisburne – Pt Hope (ERA121). One Boundary Segment was also identified as important to gray whales of the coast of Chukotka, RusCh C Dezhnev (BS 2) (Table A.1-11). The OSRA model estimates <5% chance of contact to N Chukotka Nearshore 2 (ERA 82), Pt Hope Offshore (ERA 107), and Barrow Feeding Aggregation (ERA 108) from all LAs and PLs within 30 or 360 days (Tables A.2-3 and 6).

ERAs with ≥5% chance of contact from any individual LA or PL include Chukchi Sea Spring Lead 1 (ERA 49), Chukchi Sea Spring Lead 2 (ERA 53), Chukchi Sea Spring Lead 3 (ERA 54), Hanna Shoal Area (ERA 56), Pt Lay – Barrow BH GW SFF (ERA 61), N Chukokta Nearshore 3 (ERA 83), Rus CH GW Fall 1 (ERA 120), and C Lisburne – Pt Hope (121), within 30 days is 6-22% from any individual LA, and 5-36% from any individual PL (Table A.2-3). Similarly the chance of oil contacting the same ERAs is 5-24% from any individucal LA and 5-37% from any individual PL within 360 days (Table A.2-6). The chance of contact to ERAs 49, 53, 54, 56, and 61 are analyzed above. The annual chance of a large spill contacting RusCh C Dezhnev (BS 2) from any LA or PL is <5% (Tables A.2-21and A.2-24), will not be discussed further.

The Pt Hope Offshore ERA (ERA 107), and the RusCH C Dezhnev BS (BS 2) were identified as important to humpback whales; however, the annual probability of contact by spills from all LAs and PLs were <5% (Tables A.2- 4, A.2-6, A.2-21, and A.2-24). Pt Hope Ofshore (ERA 107) was also identified as important to fin whales (Table A.1-11). No ERAs, BSs, or other features were identified as important concentration areas or habitat for other cetacean species.

Combined Probabilities. ERAs with combined probabilities <5% are not analyzed further; however, their supporting information may be found on Table A.2-73.The chance of one or more large spills occurring and contacting ERAs ≥5% includes ERAs 1, 53, 54, 61, 119, 123, and 124. The combined probabilities for these ERAs (1, 53, 54, 61, 119, 123, or 124) ranges from 7-20% and 5-21% within 30 days and 360 days, respectively. Of all the ERAs with a chance of occurrence and contact, Pt Lay-Barrow BH GW SFF (ERA 61) has the highest chance of occurrence and contact;20% and 22% within 30 and 360 days, respectively (Table A.2-73). Chukchi Sea Spring Lead 2 (ERA 53) has a combined probability of 11% and 12% within 30 and 360 days, respectively. Bowhead, beluga, and gray whales using lead systems during their spring migration could be affected if these areas are oiled. If a large amount of oil were to become trapped in a lead system (ERAs 21-37, 45, 49, 53, and 54), tens to thousands of whales could be exposed to oil.

Ice Seal ERAs

Depending upon the origination point of a large spill within the Leased Area or along a pipeline, large spills could contact ice seal habitat; however, spills contacting certain concentration areas could have greater effects than as would occur in in the general context. Such concentration areas have been delineated as ERAs and GLSs which are discussed below.

Conditional Probabilities. Sea-ice habitats can be categorized as landfast, persistent flaw zones or leads, polynyas, divergence zones, and the ice edge or front. Ringed seals occur in all of these ice zones. Bearded seals are found in all ice types except landfast ice. Ribbon and spotted seals are found along the ice edge in late winter thru early spring (February through April). In summer, ribbon seals remain in open waters, while spotted seals use a variety of shoreline and sandbar haulouts, and mostly remain in nearshore habitats (Burns, Shapiro and Fay, 1980). It is difficult to identify particular areas for oil-spill analysis because the primary habitat—sea ice—is a constantly changing environment.

However, a set of consistent locations (see Appendix A, Tables A.1-13, A.1-14) have been identified and analyzed in this section. Areas that remain consistent among years and that were identified for this analysis as important to ringed and bearded seals include the spring lead systems in the Beaufort Sea (ERAs 30-37, 45) and Chukchi Sea Lead System 4 (ERA 48), and Herald Shoal Polynya 2 (ERA 62) in the Chukchi Sea; Hanna Shoal (ERA6); Peard Bay Area (ERA 64) and Wrangel Island 12 nmi (14 mi or 22 km) Buffer 2 (ERA 46) where ice seals would concentrate in winter for access to water. Ribbon seals are mostly seasonal occupants of the southern Chukchi Sea and no known ERAs were identifiable for this species. Likewise spotted seals are seasonal residents of the Chukchi and Beaufort Seas, and their main haulouts are located at Kasegaluk Lagoon (ERA 1) and SUA Shishmaref, North (ERA 5), Peard Bay/Franklin Spit Area (ERA 64); and in Smith Bay (ERA65) and Harrison Bay (ERAs 68-69) in the Beaufort Sea. Kotzebue Sound (ERA 104), and Kolyuchin Bay (GLS 135) in the Chukchi Sea are also import areas for both spotted and ringed seals.

Large Spills: Annual. The following discussion summarizes contacts from LAs and PLs annually, unless otherwise specified for values ≥5%, of a large spill contacting habitats important to seal habitat, and only values ≥5% are analyzed in the following paragraphs. In this analysis, large oil-spill contact less than 5% would likely be too small, widely dispersed and weathered to produce appreciable impacts on seal habitat based on the large spill assumptions in Table 4-3. Additional information relevant to seasonal spills may be obtained in Appendix A.

Annually, the OSRA model estimates the percent chance of a large oil spill contacting the Beaufort Chukchi Sea spring lead systems (ERA 48), Kolyuchin Bay (GLS 135), Smith Bay Spotted Seal Haulout (GLS 153), SUA: Shishmaref North (ERA 5), Smith Bay: Spotted Seal Haulout (ERA 65), Harrison Bay/Colville Delta (ERA 69), Kotzebue Sound (ERA 104), Harrison Bay Spotted Seal Haulout (GLS 155), and sites for spotted seal haulouts on the Chukotkan coastline (LSs 33-39) within 30 or 360 days as <5% for all LAs and PLs. For the reasons analyzed above, only ERAs, LSs, and

GLSs with annual conditional probabilities and combined probabilities ≥5%, within 30 and 360 days are analyzed from this point forward.

The OSRA model estimates the annual chance of a large spill contacting any offshore ERA important to seals (Table A.1-14) ranges from 5-20% for any individual LA and from 6-36% from any individual PL for values ≥5%, within 30 days (Table A.2-3); for 360 days, that chance ranges from 5-22% from any individual LA and from 5-37% from any individual PL (Table A.2-6), depending on the distance between LAs/PLs and ERAs (Maps A-5 and A-2a through f). For the ranges analyzed above, the highest annual chance of contact occurs from LA 11 or PL 6 to Chukchi Sea Lead System 4 (ERA 48).

The OSRA model estimates the annual percent chance (≥5%) of a large oil spill contacting specific ERAs from any individual LA or PL ranges as follows:

- Chukchi Sea spring lead system 4 (ERA 48) is from 5-36% and 6-37% from LAs 5, 6, 10, 11 or PLs 3, 5, 6, 8, 9 within 30 and 360 days, respectively
- Kasegaluk Lagoon (ERA 1) is 9% within 30 and 360 days from PL6, and all other LAs and PLs are <5%
- Peard Bay/Franklin Spit area (ERA64) is from 6-16% (LA10, 11, PLs 5, 6, 8, 9) and 5-16% (LAs 4, 5, 10, 11, any PL) within 30 and 360 days, respectively
- Herald Shoal Polynya 2 (ERA 62) is from 5-11% (LAs 4, 5, 6, 11, PLs 2, 5) and 5-12% (any LA or PL) within 30 and 360 days respectively
- Hanna Shoal (ERA 6) is from 7-30% (LAs 5, 6, 11, PLs 5, 8, 9), and 6-33% (any LA or PL) within 30 and 360 days respectively
- Wrangel Island 12 nmi (14 mi or 22 km) Buffer 2 (ERA 46) is from 5% from LA 1, and 5-9 % (LAs 1, 4, 5, 6, PLs 2, 5, 8) within 30 and 360 days respectively

Combined Probabilities. ERAs with combined probabilities <5% are not analyzed further; however, their supporting information may be found on Table A.2-73. The chance of one or more large spills occurring and contacting habitat important to ice seals (ERAs 6, 48, 62, or 64) ranges from 7-20% within 30 days. Within 360 days, contact to ERAs 1, 6, 46, 48, 62, or 64 ranges from 5-22%. The chance of one or more large spills occurring and contacting habitat important to ice seals (ERAs 1, 6, 46, 48, 62, or 64) ranges from 7-20% and 5-21% within 30 days and 360 days, respectively. Of all the ERAs with a chance of occurrence and contact, Chukchi Sea Lead System 4 (ERA 48) is the highest (Table A.2-73). Though ringed and bearded seals could be contacted year-round in these areas, contact during the winter would have the greatest effect when seals are more concentrated around the ice-pack shear zone surrounding Wrangel Island 12 nmi (14 mi or 22 km) Buffer 2 (ERA 46), Chukchi Sea lead system 4 (ERA 48), Hanna Shoal (ERA 6), and Herald Shoal Polynya 2 (ERA 62).

Pacific Walrus ERAs

A large oil spill that occurred in summer, or in winter and persisted into summer, could impact walrus coming ashore due to sea-ice retreat, or in the spring lead system, and along the ice edge. Although walrus depend largely on sea ice as a platform in the Chukchi Sea, this is changing as summer pack ice diminishes (Monson, Udevitz, and Jay, 2013; USFWS, 2013; Jay, Fischbach, and Kochnev, 2012). In summer 2007, walrus were found hauling out near Barrow, and a large terrestrial haulout formed in late summer near Cape Lisburne. Since that time, large haulouts of tens of thousands of walrus have formed in late September-October near Point Lay in years when sea ice has retreated northward of the continental shelf (USFWS, 2013c). On September 27, 2014, NOAA Fisheries estimated the walrus haulout at Point Lay to be approximately 35,000 animals (NOAA, 2014a). It is difficult to predict where walrus might be found, because their distribution depends heavily on sea ice. In recent years, large terrestrial haulouts also have been forming along both the Russian and U.S. coastlines of the Chukchi Sea as the sea ice retreats north of the continental shelf (USFWS, 2013b,c).

For this analysis, BOEM focused on Cape Lisburne and adjacent waters (ERA 15) and GLS 145, the Hanna Shoal Walrus Use Area (HSWUA) (ERA 47), the Point Lay polynya area (ERA 50), the Point Lay haulout area and adjacent waters (ERA51) on the U.S. side of the Chukchi Sea, and the LSs where the Point Lay haulout has occurred in recent years (GLS 147).

BOEM also analyzed the chance of contact to large, traditional walrus haulout areas on the Russian side of the Chukchi Sea. These included Wrangell Island and a 12-nmi (14 mi or 22 km)) buffer around the island (ERA11), Mys Blossom (GLS 133) and Bukhta Somnitel'naya (GLS 134): both haulouts on Wrangel Island, Ostrov Kolyuchin (ERA59), Herald Island (ERA66), Mys Vankarem (LS 28), Mys Onmyn (LS 29), Ostrov Ididlya (GLS 136), Mys Serditse Kamen (GLS 137), Mys Unikin (LS 38), and Mys Dezhnev (LS 39). Based on USGS tagging data, BOEM added two additional ERAs offshore of the southern Russian coast (ERA 52) and nearshore of the southern Russian coast (ERA 58). BOEM also added two sections of grouped land segments along the Russian coastline to capture walrus haulouts along that Russian coastline, (GLS 138 and GLS 174).

Summer Spills. For summer, the OSRA model estimates the percent chance of a large oil spill contacting:

- Wrangel Island (ERA 11) is 2 to 8% and 4 to 12% within 30 and 360 days, respectively for all LAs and PLs.
- Cape Lisburne (ERA 15) is <0.5-13% and 1-30% within 30 days and 360 days, respectively for all LAs and 1-24% within 30 and 360 days for all PLs.
- HSWUA (ERA 47) is 17-75% and 20-76% within 30 and 360 days, respectively for all LAs and from 12-55% and 14-57% within 30 and 360 days, respectively for all PLs except PL8. Because PL8 is placed within the HSWUA, any spill from PL 8 would contact the HSWUA. The percent chance of contact to the HSWUA area is high because of its proximity to the Leased Area. Some LAs and PLs are adjacent to or within the HSWUA. If a trajectory contacts any portion of the HSWUA, it is considered contacted. The conditional probabilities should not be interpreted as indicating what percent area of the HSWUA is contacted; rather they represent the percent chance of contact to any portion of the HSWUA.
- Point Lay offshore (ERA50) is 3-40% and 3-41% within 30 and 360 days, respectively for all LAs and from 3-60% within 30 and 360 days for all PLs.
- Point Lay nearshore (ERA 51) is 1-11% and 1-12% within 30 and 360 days, respectively for all LAs and from 1-38% within 30 and 360 days for all PLs.
- Russian coast offshore (ERA 52) is 5-20% and 6-20% within 30 and 360 days, respectively for all LAs and from 5-24% and 6-25% within 30 and 360 days respectively for all PLs.
- Russian coastline nearshore (ERA 58) is1-8% and 2-8% within 30 and 360 days, respectively for all LAs and from 2-11% within 30 and 360 days for all PLs.
- Ostrov Koluchin (ERA 59) is <0.5-2% and 1-2% within 30 and 360 days, respectively for all LAs and from <0.5-2% and 1-3% within 30 and 360 days, respectively for all PLs.
- Herald Island (ERA 66) is 1-3% for all LAs and PLs within 30 days. Within 360 days, the percent chance is 2-4% for LAs and 1-3% for PLs.
- LS 28 or 29 is <0.5-1% within 30 and 360 days, respectively for all LAs and PLs.
- LS 38, 39 or GLS 134 (Bukhta Somnitel'naya) is <0.5% within 30 days and 360 days for all LAs and PLs.

- GLS 133 (Mys Blossom) is 1-5% and 2-8% within 30 and 360 days, respectively for all LAs and for all PLs.
- GLS 136 (Ostrov Ididlya) or 137 (Mys Serditse Kamen) is <0.5-2% within 30 and 360 days for all LAs and all PLs.
- GLS 138 (Chukotka Coast Haulout) is <0.5-3% within 30 days for all LAs and PLs. Within 360 days, the percent is from 1-3% for LAs and from <0.5-4% for PLs.
- GLS 145 (Cape Lisburne) is <0.5-3% for all LAs and from <0.5-4% for all PLs within 30 and 360 days.
- GLS 147 (Point Lay Haulout) is <0.5-5% for all LAs and from <0.5-12% for all PLs within 30 and 360 days.
- GLS 174 (Russia Chukchi Sea Coast Marine Mammals) is 8-19% and 13-23% for all LAs and is 6-19% and 10-23% for all PLs within 30 and 360 days, respectively.

During development careful selection of pipeline locations could appreciably lower the chance of contact for many areas. For more information, see Appendix A, Tables A.2-27 through A.2-42.

Winter Spills. For summer, the OSRA model estimates the percent chance of a large oil spill contacting:

- Wrangel Island (ERA 11) is <0.5-2% for all LAs and <0.5-1% for all PLs within 30 days. Within 360 days, the percent chance is from 2 to 3% for all LAs and PLs.
- Cape Lisburne (ERA 15) is <0.5-1% and <0.5-2% within 30 days and 360 days, respectively for all LAs and <0.5-3% within 30 and 360 days for all PLs.
- HSWUA (ERA 47) is 2-11% and 4-15% within 30 and 360 days, respectively for all LAs and from 2-18% and 9-22% within 30 and 360 days, respectively for all PLs.
- Point Lay offshore (ERA50) is <0.5-5% for all LAs and <0.5-5% for all PLs within 30 and 360 days.
- Point Lay nearshore (ERA 51) is <0.5-1% for all LAs and <0.5-6% for all PLs within 30 and 360 days.
- Russian coast offshore (ERA 52) is 1-9% and 2-11% for all LAs within 30 and 360 days, respectively and 1-11% and 2-14% for all PLs within 30 and 360 days, respectively.
- Russian coastline nearshore (ERA 58) is <0.5-3% and 1-4% within 30 and 360 days, respectively for all LAs and from <0.5-4% and 1-5% within 30 and 360 days, respectively for all PLs.
- Ostrov Koluchin (ERA 59) is <0.5%for all LAs and <0.5-1% for all PLs within 30 and 360 days.
- Herald Island (ERA 66) is <0.5-% for all LAs and PLs within 30 and 360 days.
- LS 28 or 29 is 1-2% for all LAs and for all PLs within 30 days. Within 360 days, the percent chance is 1-3% for all LAs and 2-3% for all PLs.
- LS 38, 39 is <0.5-1% within 30 days and <0.5-2% within 360 days for all LAs and PLs.
- GLS 133 (Mys Blossom) is <0.5-1% and 2-3% within 30 and 360 days, respectively for all LAs and PLs.
- GLS 134 (Bukhta Somnitel'naya), GLS 136 (Ostrov Ididlya), 137 (Mys Serditse Kamen) or GLS 145 (Cape Lisburne) is <0.5within 30 and 360 days for all LAs and all PLs.
- GLS 138 (Chukotka Coast Haulout) is <0.5-2% for all LAs and PLs within 30 days. Within 360 days, the percent chance is 1-3% for LAs and PLs.

- GLS 147 (Point Lay Haulout) is <0.5-1% for all LAs and from <0.5-7% for all PLs within 30 and 360 days.
- GLS 174 (Russia Chukchi Sea Coast Marine Mammals) is 5-6% and 14-17% for all LAs and is 5-7% and 12-16% for all PLs within 30 and 360 days, respectively.

For more information, see Appendix A, Tables A.2-27 through A.2-42.

Combined Probabilities

Combined probabilities differ from conditional probabilities in that there is no assumption that a large spill has occurred. Instead, combined probabilities reflect the chance of one or more large spills occurring over the life of the Scenario, and of any portion of that spill contacting any portion of a particular ERA. Combined probabilities do not factor in any cleanup efforts. For more background information, see Appendix A, Section A-4.3. The combined probabilities given below reflect the percent chance of one or more large spills occurring and contacting the ERA, LS or GLS if Alternative I, III, or IV is selected.

The combined probabilities of one or more large spills occurring and any portion of that spill contacting the Wrangel Island ERA 11 is <0.5% within 30 days after the spill and 3-6% within 30 to 360 days after the spill. The combined probabilities of one or more large spills occurring and any portion of that spill contacting the Cape Lisburne ERA 15 is 1% within 3 days, 3% within 10 days and 4-5% within 30 to 360 days. The combined probabilities of one or more large spills occurring and any portion of that spill contacting the HSWUA ERA 47 is 9% within 3 days, 14% within 10 days, and 21-25% within 30-360 days. The combined probabilities of one or more large spills occurring and any portion of that spill contacting the Point Lay walrus offshore ERA 50 is 11% within 3 days, and 14-17% within 10-360 days. The combined probabilities of one or more large spills occurring and any portion of that spill contacting the Point Lay walrus nearshore ERA 51 is 6-8% within 3 to 360 days. The combined probabilities of one or more large spills occurring and any portion of that spill contacting the Russian coast walrus offshore ERA 52 is <0.5% within 3 days, 3% within 10 days, and 10-12% within 30-360 days. The combined probabilities of one or more large spills occurring and any portion of that spill contacting the Russian coast walrus nearshore ERA 58 is <0.5-1% within 3-10 days and 3-4% within 30-360 days. The combined probabilities of one or more large spills occurring and any portion of that spill contacting the Ostrov Kolyuchin ERA 59 is <0.5% within 3-10 days and 1% within 30-360 days. The combined probabilities of one or more large spills occurring and any portion of that spill contacting the Herald Island ERA 66 is <0.5% within 3-10 days and 1-2% within 30-360 days (Table A.2-73).

The combined probabilities of one or more large spills occurring and any portion of that spill contacting LS 28 or LS 29 is <0.5% within 10 days, 1% within 30 days after the spill and 2% within 60-360 days. The combined probabilities of one or more large spills occurring and any portion of that spill contacting LS 38 or 39 is <0.5% within 3-30 days and 1% within 60-360 days (Table A.2-74).

The combined probabilities of one or more large spills occurring and any portion of that spill contacting GLS 133 is <0.5% within 3-10 days, 1% within 30 days and 2-4% 60-360 within days. The combined probabilities of one or more large spills occurring and any portion of that spill contacting GLS 134 is <0.5% within 3-360 days. The combined probabilities of one or more large spills occurring and any portion of that spill contacting GLS 136 or GLS 137 is <0.5% within 3-10 days and 1% within 30-360 days. The combined probabilities of one or more large spills occurring and any portion of that spill contacting GLS 138 is <0.5% within 3-10 days, 2% within 30-60 days, and 3% within180 to 360 days. The combined probabilities of one or more large spills occurring and any portion of that spill contacting GLS 145 is <0.5 -1% within 3-360 days. The combined probabilities of one or more large spills occurring and any portion of that spill contacting GLS 147 is 2% within 3 days, 3% within 10 days and 4% within 30- 360. The combined probabilities of one or more large spills occurring and any portion of that spill contacting GLS 174 is <0.5% within 3 days, 1% within 10 days, 11% within 30 days, and 15-19% within 60-360 days.

Walrus have a patchy, clumped distribution, which makes it difficult to evaluate the risk to walrus from a large oil spill. During early spring and summer months, nearly the entire population of Pacific walrus can be found in the Chukchi Sea, and they could be extremely vulnerable to a large oil spill at this time. Areas where walrus are largely concentrated at some times of the year and therefore more vulnerable include the HSWUA, and Hanna Shoal as defined by NMFS (2013) or by the Marine Mammal Commission (MMC) (MMC, 2013 as described in Smith, 2011), terrestrial haulout areas near Point Lay and the Russian coastline (USFWS, 2013b,c; Jay, Fischbach, and Kochnev, 2012). Careful placement of pipelines during development could reduce this risk. Efficient oil-spill-cleanup efforts could reduce this risk further. Should a large oil spill occur, the risk to walrus would depend upon the location, the time of year, and the effectiveness of cleanup efforts. A large oil spill occurring in or near the HSWUA or Hanna Shoal (as defined by NMFS or by the MMC) during peak foraging periods could result in a moderate impact to walrus due to the high densities of walrus concentrated in the Hanna Shoal region.

Oil-spill-response plans and oil-spill-management plans are flexible. For example, to adequately protect walrus and their habitat from the threat of a large oil spill or chronic small spills, mitigation measures currently in place must be adapted to continued changes in walrus distribution and habitat use and to new information—for example, the increasing use of the coastline for terrestrial haulouts in late summer and fall, and the recognition of the importance of Hanna Shoal from recent tagging studies. The effectiveness of oil-spill-response measures would depend largely on the location of the spill, the distances involved, the season, and the weather along the Chukchi Sea coast.

In general, oil-spill-response activities include containing the release and spread of oil, recovering oil as quickly as is safely possible, and keeping oil away from areas identified as important habitats using boom or other resources. Areas identified in spill-response documents and on maps as important habitat for walrus include haulout areas near Point Lay and Cape Lisburne, and the HSWUA (ADEC 2012, p. D-43).

Polar Bear ERAs

Polar bears move north and south with the pack ice in the Chukchi Sea and are vulnerable to spills at any time of the year (USFWS, 2006). Spills during the fall or spring during the formation or breakup of ice present a greater risk because of difficulties associated with cleanup during these periods and the presence of bears in the prime feeding areas over the continental shelf (USFWS, 2006). Oil would remain highly toxic to polar bears, even after the aromatic hydrocarbons have dissipated (St. Aubin, 1990). In general, polar bears can be encountered throughout the ice-covered waters of the Chukchi Sea. They are less likely to be found in open water, but they will swim considerable distances from ice to shore, or vice versa (USFWS, 2006). As sea ice breaks up in spring, polar bears follow the receding ice edge and may come ashore in late summer and fall, where they remain until the sea ice reforms in early winter. Large aggregations of polar bears may be vulnerable to a spill along the arctic coasts or on Wrangel or Herald islands in late summer and fall, when they congregate in these areas to feed on walrus and whale carcasses (USFWS, 2006). Indirect sources of mortality may occur when seals or other mammals die from oil exposure. Bears have an excellent sense of smell and will travel long distances to locate food sources. Polar bears may not avoid their usual prey items due to oiling (St. Aubin, 1990; Neff, 1990; Derocher and Stirling, 1991). Ingesting oiled prey would be likely to be a secondary source of mortality from a spill. Both adult and young bears that are hungry are likely to scavenge contaminated seals, as they have shown no aversion to eating and ingesting oil (St. Aubin, 1990; Neff, 1990; Derocher and Stirling, 1991).

Increasing trends in polar bear use of terrestrial habitat in fall are likely to continue, as sea-ice conditions continue to change (USFWS, 2006). Some OCS operations might pose a relatively high spill risk to polar bear aggregations and, therefore, to the polar bear population as a whole. In March 2006, more than 4,790 bbl (200,000 gal) of oil spilled onto the tundra on the North Slope as a result of a leak in a corroded pipeline that went undetected for an extended length of time (USFWS, 2006). As demonstrated by this spill, small, chronic leaks in underwater pipelines could result in large volumes of oil being released underwater without detection. If such an event were to occur in offshore waters, there could be major impacts to the polar bear population. If such a spill occurred during winter, the release of oil trapped under the ice during spring breakup would be equivalent to the catastrophic release of the same amount of oil (Amstrup, Durner, and McDonald, 2000). The continued use of technology, such as the LEOS leak-detection system, can greatly enhance the ability to detect small leaks so they do not become large spills over time.

Oil-Spill Analysis

An ERA can represent an area important to one or several species or species groups during a discrete amount of time. This section analyzes risk to polar bears. A list of polar bear ERAs, LSs and GLSs can be found in Appendix A, Table A.1-13. Oil-spill impacts to ice seals, such as ringed seals, could impact polar bears by limiting prey available to them, or by causing mortality from secondary contamination. ERA 11 (Wrangel Island), ERA 59 (Ostrov Kolyuchin), ERA 66 (Herald Island), GLS 134 (Bukhta Somnitel'naya) and GLS 174 (Russian coastline) have all been identified as important areas for polar bears. These resource areas were previously analyzed in the walrus section and that analysis is not repeated here.

Additional ERAs analyzed in this section are ERA 23 in the southeastern portion of the Chukchi Sea; this area has been identified by USFWS as important polar bear habitat in a letter to BOEM (USFWS, 2013b), ERA 55: Point Barrow and the Plover Islands, ERA 92: Thetis, Jones, Cottle and Return Islands, ERA 93: Cross and No Name Islands, ERA 94: Maguire, Flaxman, and Barrier Islands, ERA 95: Arey and Barter Islands and Bernard Spit. LSs and GLSs identified as important habitat for polar bears are LS 85: Barrow, Browerville and Elson Lagoon, and GLSs 157, 159, 160, 166, 167, 170, and 171. These GLSs represent sections of the Beaufort Sea coastline adjacent to areas important to polar bears in summer, fall, winter or spring (Derocher et al., 2013).

Conditional Probabilities

The OSRA model calculates conditional probabilities (expressed as a percent chance) of a spill contacting identified polar bear habitats (ERA polygons, LSs, or GLSs). Conditional probabilities are based on the assumption that a large spill has occurred (for further explanation, see Appendix A). For a map of the hypothetical platform locations (LAs) and the hypothetical pipeline routes that the model uses for the oil-spill-trajectory analysis, see Appendix A, Map A-5. There are 6 LAs and 6 PLs considered in the model.

Summer Spills

A summer spill could impact polar bears coming ashore due to sea-ice retreat or in preparation for denning later in the fall/winter season. The areas in the Chukchi Sea that would be particularly important include Wrangel Island, Herald Island, and Ostrov Kolyuchin (Kolyuchin Spit), areas where polar bears come ashore to feed on walrus carcasses and to den. Polar bear dens also can be found along both the U.S. and Russian coasts of the Chukchi Sea (Fischbach et al., 2007). A large spill in the Chukchi Sea could impact the coastline of the Beaufort Sea, as well as the barrier islands near Point Barrow and Barrow.

For summer spills, the OSRA model estimates the percent chance of a large oil spill contacting ERA 23 within 30-360 days is <0.5-14% for all LAs and 1-16% for all PLs. The percent chance of a large oil spill contacting ERA 55 within 30-360 days is <0.5-1% for all LAs and <0.5-2% for all PLs. The percent chance of a large oil spill contacting ERAs 92, 93, 94 or 95 is <0.5% for all LAs and for all PLs (Tables A.2-27 and 30). For summer spills, the OSRA model estimates the percent chance of a large oil spill contacting LS 85 is 1-6% from all LAs and 2-10% from all PLs (Tables A.2-33 and 36). For summer spills, the OSRA model estimates the percent chance of a large oil spill occurring and contacting GLS 157, 159, 160, 166, 167, 170, or 171 is <0.5% from all LAs and PLs (Tables A.2-39 and 42).

Winter Oil Spills

A large spill during winter could impact polar bears on nearshore or offshore ice. A large spill in winter would be difficult to clean up, and oil could become entrained in the ice, melting out in spring and contacting lead systems and coastal areas. In winter, polar bears range throughout the ice-covered waters of the Chukchi Sea. They may be found near polynyas and open lead systems where they prey on seals.

The OSRA model estimates the percent chance of a large spill contacting the ERAs and coastal areas that are important resource areas to polar bears. The OSRA model estimates the percent chance of a large oil spill contacting ERA 23 within 30 days is 3-70% for all LAs and 10-78% for all PLs. The percent chance of a large oil spill contacting ERA 23 within 360 days is 6-71% for all LAs and 13-79% for all PLs. The percent chance of a large oil spill contacting ERA 55 within 30 days is <0.5% for all LAs and is <0.5-1% for all PLs. The percent chance of a large oil spill contacting ERA 55 within 360 days is <0.5-1% for all LAs and PLs. The percent chance of a large oil spill contacting ERAs 92, 93, 94 or 95 is <0.5% for all LAs and for all PLs (Tables A.2-51 and 54).

For winter spills, the OSRA model estimates the percent chance of a large oil spill occurring and contacting LS 85 is <0.5 -2% from all LAs and <0.5-4% from all PLs (Tables A.2-57 and 36). For winter spills, the OSRA model estimates the percent chance of a large oil spill contacting GLSs 157, 159, 160, 166, 167, 170, or 171 as <0.5% from all LAs and PLs (Tables A.2-63 and 66).

Polar Bear Habitat

BOEM considered large offshore habitat areas in addition to the ERAs and GLSs input into the OSRA trajectory model for polar bears shown in Table A.1-14. Information gathered through study of tagged polar bears in the southern Beaufort Sea was integral to developing a robust analytical approach, and therefore is presented here as necessary background.

Southern Beaufort Sea

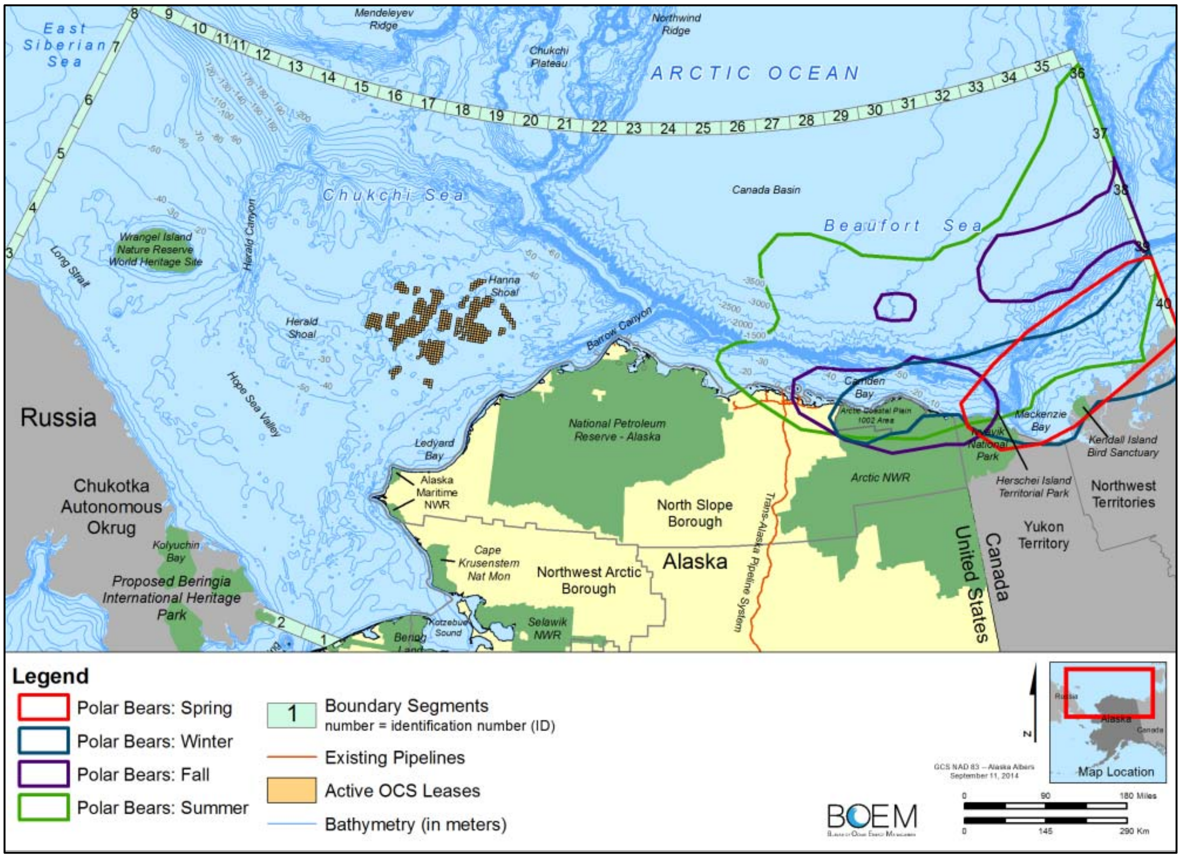


Figure 4-9. Beaufort Sea Polar Bear Habitat by Season. *Illustration based on actual collared female and sub-adult polar bears from the southern Beaufort Sea population. Source: Derocher et al., 2013; Figure 13).*

In 2013, BOEM received a final report for a BOEM-funded study led by Dr. Andrew Derocher of the University of Alberta (Derocher et al., 2013). The results of the study included habitat analyses based upon 65 collared female and sub-adult polar bears. The polar bears were collared in the eastern portion of the southern Beaufort Sea. Movement data from these polar bears were used to delineate important polar bear habitat in the southern Beaufort Sea. Dr. Derocher and his team identified areas used by polar bears in spring, winter, fall and summer during 2007-2010 (Derocher et al., 2013; Figure 13). BOEM used the minimum convex polygon (95%) and seasonal and annual kernel home ranges (75% for all polar bears) monitored by GPS satellite telemetry (Derocher et al., 2013; Figure 13) to determine the polygons used for polar bear habitat by season shown in Figure 4-9.

Each seasonal habitat area was analyzed as a polygon in the OSRA model. Due to the large size of the habitat polygons, a gridded overlay methodology was used to assess whether any portion of each polygon would be contacted by a large spill starting within any of the 6 LAs. These are conditional probabilities; the estimate is based on assuming that a large spill has occurred. This chance of contact has not been weighted by the chance of one or more large spills occurring. In the analysis, a large spill originating between June 1 and October 31 is identified as a summer spill, while a large spill originating between November 1 and May 31 is identified as a winter spill. Table 4-49 shows the percent chance of contact and is further analyzed below.

Table 4-49. Polar Bear–Chance of Large Spill reaching SBS Polar Bear Habitat[1] by Season.

SBS Seasonal Habitat Polygon[1]	Summer 360 days		Winter 360 days	
Polar Bears: Spring	<0.5% All LAs		<0.5% All LAs	
Polar Bears: Winter	<0.5% All LAs		<0.5% All LAs	
Polar Bears: Fall	<0.5% All LAs		<0.5% LA 4, 5, 10	≤1% LAs 1, 6, 11
Polar Bears: Summer	<0.5% LAs 1, 4, 5 or 6	≤1% LAs 10 or 11	<0.5% LA10	≤1% LAs 1, 4, 5, 6,11

Notes: Table illustrates the percent chance of a large spill contacting any portion of seasonal polar bear habitat[1] within 360 days during summer or winter.

[1]SBS = Southern Beaufort Sea; BOEM used the minimum convex polygon (95%) and seasonal and annual kernel home ranges (75% for all polar bears) monitored by GPS satellite telemetry.

Source: Derocher et al. (2013, Figure 13) as SBS seasonal Habitat.

The percent chance of a large spill contacting a portion (grid cell) of the Southern Beaufort Sea spring or winter polar bear habitat within 360 days is <0.5% for a large spill starting during summer or winter from any LA. The percent chance of a large spill contacting any portion (grid cell) of fall polar bear habitat is <0.5% within 360 days during summer, or any spill during winter from LAs 4, 5, or 10. The percent chance of a large spill contacting any portion (grid cell) of fall polar bear habitat is <0.5% within 30 days during winter from LAs 1, 6, or 11 and ≤1% within 60, 180 or 360 days. The percent chance of a large spill contacting any portion (grid cell) of summer polar bear habitat is <0.5% within 360 days during summer from LAs 1, 4, 5 or 6. From LAs 10 or 11, the percent chance of a large spill contacting a portion (grid cell) of summer polar bear habitat is <0.5% within 60 days, and ≤1% within 180 or 360 days during summer. The percent chance of a large spill contacting any portion (grid cell) of summer polar bear habitat is <0.5% within 10 days during winter from any LA or for 360 days from LA 10, and ≤1% within 30, 60, 180 or 360 days from LAs 1, 4, 5, 6, or 11. In summary, the percent chance of any of the identified polar bear seasonal habitats being contacted by a large spill from any of the LAs is ≤1% during summer or winter.

Beaufort and Chukchi Seas

Similarly, the USFWS used polar bear movement data from female polar bears collared in the southeastern Chukchi Sea and in Kotzebue Sound to delineate important polar bear habitat in winter and spring. These polygons represent all of the areas that had a >75% chance of use during two or more years of the study (Figure 4-10). These seasonal areas were analyzed as polygons in the OSRA model. Due to the large size of the winter and summer polygons, a gridded overlay methodology was used to assess whether any portion of each polygon was contacted by a large spill starting within any of the 6 LAs.

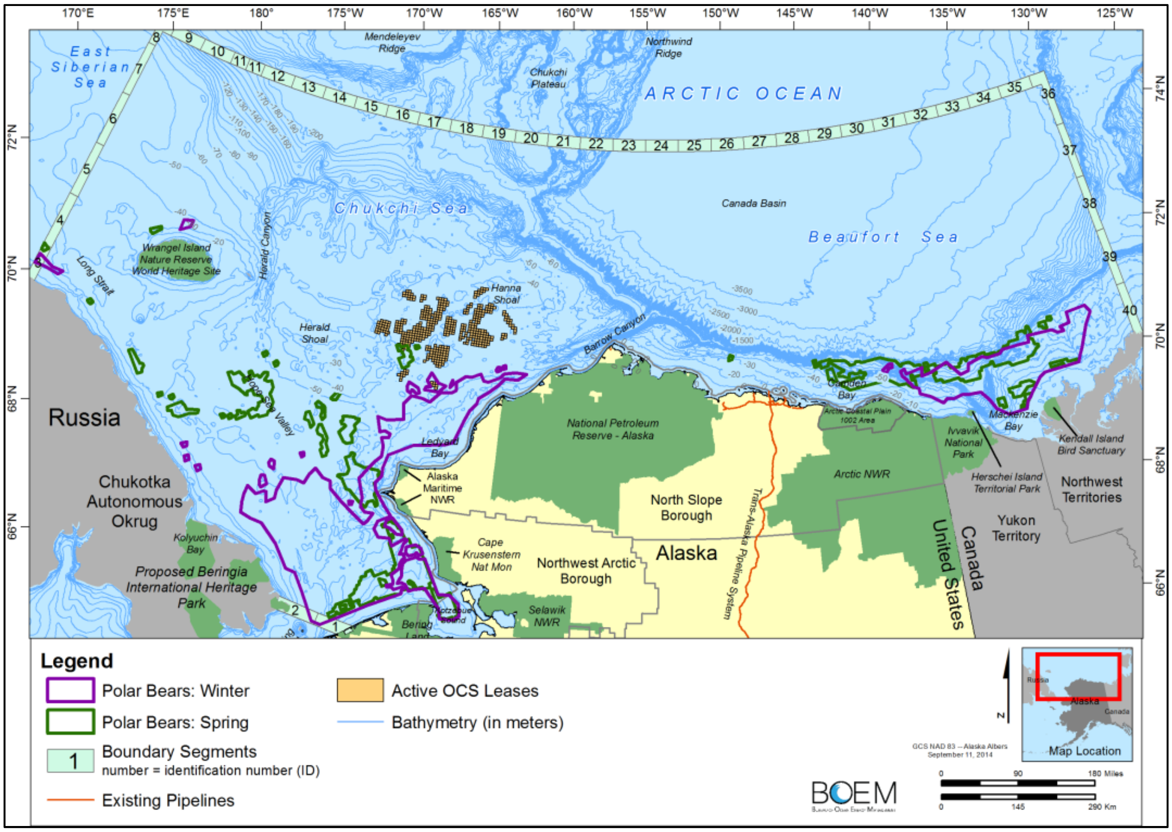


Figure 4-10. Chukchi and Bering Sea Polar Bear Habitat by Season. *Based on actual collared female polar bears from the Chukchi/Bering Sea population. Source: USFWS, 2013a,b).*

As may be expected given the large size of the polygons and the proximity to the LAs, the results were more variable. For spring polar bear habitat, the percent chance that a large spill originating from LAs 1, 6, 10 or 11 would contact any portion of polar bear habitat within 360 days is <10% during summer or winter. Because LA 4 and LA 5 overlap with spring polar bear habitat, a large spill originating from LA 4 or 5 would contact a portion of spring polar bear habitat. For these LAs, BOEM evaluated the chances of a large spill contacting spring polar bear habitat and the number of grid cells (as a proxy for area) for that percent chance of contact (Table 4-50). If any portion of a grid cell is contacted, it is considered "contacted." Spring polar bear habitat encompasses 537 grid cells.

Table 4-50. Polar Bear Spring Habitat[1] Grid Cells and Chance of Oil Contact.

LA and Time Period	Number of Grid Cells Contacted <0.5%	Number of Grid Cells Contacted	Range of Percent Chance of Contact	Number of Grid Cells Contacted >99.5%
		LA 4 Summer		
3 Days	504	31	1-3%,	2
30 Days	362	173	1-9%,	2
360 Days	346	189	1-10%,	2
		LA 4 Winter		
3 Days	510	25	1-6%,	2
30 Days	369	166	1-12%,	2
360 Days	360	175	1-13%,	2
		LA 5 Summer		
3 Days	522	7	4-7%,	8
30 Days	366	63	1-12%,	8
360 Days	340	189	1-13%,	8
		LA 5 Winter		
3 Days	522	7	3-5%,	8
30 Days	392	137	1-10%,	8

LA and Time Period	Number of Grid Cells Contacted <0.5%	Number of Grid Cells Contacted	Range of Percent Chance of Contact	Number of Grid Cells Contacted >99.5%
360 Days	382	147	1-11%,	8

Note: Table indicates the number of grid cells within the polar bear spring habitat1 and the percent chance of contact from launch areas 4 or 5 within 3, 30 or 360 days.

Source: USDOI, BOEM (2014b) Note: 1 As Identified by the USFWS (2013a,b).

For winter polar bear habitat, the percent chance that a large spill from LA 1, 4, 5, or 6 would contact winter polar bear habitat within 360 days is <5% during summer or winter. Because LA 10 and LA 11 overlap with winter polar bear habitat, a large spill originating from LA 10 or 11 would contact winter polar bear habitat For these LAs, BOEM evaluated the chances of a large spill contacting winter polar bear habitat and the number of grid cells (as a proxy for area) for that percent chance of contact (Table 4-51). If any portion of a grid cell is contacted, it's considered "contacted." Winter polar bear habitat encompasses 915 grid cells.

Table 4-51. Polar Bear Winter Habitat[1] Grid Squars and Chance of Oil Contact.

LA and Time Period	Number of Grid Cells Contacted <0.5%	Number of Grid Cells Contacted	Range of Percent Chance of Contact	Number of Grid Cells Contacted >99.5%
LA 10 Summer				
3 Days	793	78	1-7%	44
30 Days	440	431	1-14%	44
360 Days	406	465	1-15%	44
LA 10 Winter				
3 Days	772	99	1-7%	44
30 Days	526	345	1-13%	44
360 Days	523	348	1-13%	44
LA 11 Summer				
3 Days	800	103	1-6%	12
30 Days	548	355	1-11%	12
360 Days	486	417	1-12%	12
LA 11 Winter				
3 Days	808	95	1-6%	12
30 Days	647	129	1-10%	12
360 Days	606	297	1-10%	12

Note: The Number of Grid Cells Within the Polar Bear Winter Habitat[1] and the Percent Chance of Contact from LA 10 or 11 within 3, 30 or 360 days.

[1] As Identified by USFWS (2013a,b).

Source: USDOI, BOEM (2014b).

Combined Probabilities

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

The combined probabilities of one or more large spills occurring and any portion of that spill contacting any portion of ERA 23 is 21% within 3 days, 27% within 10 days and 30-31% within 30 to 360 days. The combined probabilities of one or more large spills occurring and any portion of that spill contacting any portion of ERA 55 is <0.5% within 3-10 days and 1% within 30-360 days. The combined probabilities of one or more large spills occurring and any portion of that spill contacting any portion of GLSs 92, 93, 94 or 95 is <0.5% within 3- 360 days. The combined probabilities of one or more large spills occurring and any portion of that spill contacting any portion of LS 85 is <0.5% within 3 days after the spill, 1% within10 days after the spill and 3-4% within 30-360 days. The combined probabilities of one or more large spills occurring and any portion of that spill contacting any portion of GLSs 157, 159, 160, 166, 167, 170, or 171 is <0.5% within 3-360 days (Appendix A, Tables A.2-73 through A.2-75). The combined probabilities do not factor in any oil-spill-cleanup efforts and do not differentiate between the amounts of oil contacting the coastline.

Oil-Spill Response

The conditional or combined probabilities do not consider the effectiveness of spill response activities to mitigate large spills which could range from highly effective under ideal conditions to largely ineffective depending upon the specific circumstance. An oil-spill response plan would be required prior to exploration or development and production activities. Oil-spill response can cause disturbance, and the use of dispersants could harm marine mammals or their prey.

Depending on the location of the spill, oil-spill response could take some time to begin. Oil-spill-response equipment is cached in Barrow and in Deadhorse, about 150 mi (241 km) east of Barrow. Additional equipment may be cached at or near Wainwright, or at another site, depending upon the location of developments. Oil-spill-response personnel would be expected to work with USFWS on walrus and polar bear management activities in the event of a spill and to work with NMFS on the management of other marine mammals present in the area.

During oil-spill-response activities, oiled carcasses would be collected when feasible, which could lessen the risk of polar bears ingesting oiled prey items. In some circumstances, oiled seals or seal carcasses floating in broken ice and in open leads would be very difficult to locate and recover. Removal of all types of oiled carcasses (birds, seals, fish, other mammals) is an important primary oil-spill response activity. This removes a source of secondary poisoing to scavengers and predators.

Hazing may be very effective in the case of small spills or in relatively discrete areas. Most marine mammals would be likely to avoid the high level of activity associated with cleanup activities. Polar bears may be curious and may approach personnel who are on shore or in vessel. Wildlife response activities could involve hazing bears away from an area; or capturing and transporting an oiled bear for cleaning and treatment though it is unlikely that an oiled bear would survive.

In general, cleanup activities could result in short or long term displacement of marine mammals from preferred habitats, loss of benthic prey from the potential use of dispersants or hot washing nearshore, and increased human interactions and disturbance. Conversely, cleanup activities would likely decrease the likelihood that marine mammals may come into contact with oil by displacing them from oiled areas.

The science on the impact to marine mammals (as well as birds, fish, and lower tropic organisms) from exposure to dispersants, either directly or indirectly, is inconclusive. Studies and traditional knowledge suggest that use of dispersants could potentially cause the following types of impacts:

- Inflammation, cell damage, ulcers, bleeding, damage to liver, kidney and brain tissues caused by direct or indirect ingestion of dispersants or dispersed oil
- Changes in productivity, survivorship and contamination of benthic sediments and invertebrates as well as pelagic zooplankton, and attendant impacts from bioaccumulation
- Increase in the toxicity of dispersed oil
- Prolonged exposure to oil in the water column or sea floor from oil that has been dispersed (i.e., longer term potential to ingest or adsorb dispersed oil)
- Adverse impacts from inhalation of dispersant vapors
- Disturbance associated with application of dispersants from offshore vessels, aircraft and onshore vehicles
- Exposure during pregnancy negatively impacting the viability of young

- Decreased food assimilation of prey eaten; and
- Attendant adverse impacts to subsistence users, whether through consumption of contaminated subsistence resources, fear or perception of tainting of these resources, or deflection of marine mammals resulting in inability to harvest them

(Würsig, 1990; Moore and Clarke, 2002; Kujawinski et al., 2011; St. Aubin, 1988; Almeda, et al., 2014; Wu et al., 2012; Kuhl, et al., 2013; Wise, et al., 2014; Zheng, et al., 2014).

Potential impacts to biological resources may vary depending on the organism's lifecycle stage at the time of exposure. Actual impacts would also vary based upon which types of dispersants, if any, are used in the event of a spill. Further, little is known about the long-term effects of dispersant exposure. Fingas (2014) notes, "There are few studies departing from the traditional lethal aquatic toxicity assay and none that focus on the longer-term effects of short term exposures." While the potential effects to biological resources from exposure to dispersants and dispersed oil are uncertain, the low probability of a large or very large oil spill occurring and leading to widespread exposure to dispersants (if used at all), the wide variety of chemical formulations used in dispersants, BOEM's lack of authority to approve use of dispersants, and the fact that the potential for such impacts would vary only slightly if at all under each action alternative, means that additional studies on the use or impacts of using dispersants are not essential to a reasoned choice among Lease Sale alternatives.

The volume of the large spills assumed to occur for purposes of analysis would prohibit any large scale effects from dispersants. Accordingly, dispersants are not further analyzed in Section 4.3, unless otherwise noted. Additional discussion of dispersants is contained in Section 4.4 (Very Large Oil Spills) and 4.5 (Effects of a VLOS).

Development and Production (Years 26-50)

During this period, Development and Production activities would continue. A Geotechnical and Geohazard survey would be conducted in Year 28, production platforms would be constructed in Years 28 and 30, two 5 mi long offshore oil pipelines linking platforms within the Satellite field would be constructed, and wells from production platforms would be drilled between Years 26 and 34. In addition, operators would gradually switch to natural gas production using much of the existing infrastructure, and 160 miles of gas pipeline linking the anchor field to the onshore facility woud be constructed in Years 27-30. As the Anchor field links to Wainwright or Barrow, 5 mi natural gas pipelines would be constructed within the Anchor field linking production platforms with the natural gas pipeline to the coast in Years 34, 37, 40, 47, and 50, and in Year 43, 25 miles of pipeline would be constructed.

Throughout this period, aircraft and vessel support would be essential for routine operations. However, with the lack of seismic surveys, exploration wells, and geohazard or geotechnical surveys after Year 28, the focus of traffic would be to directly support construction of two platforms and natural gas pipelines. Natural gas spills could occur from Year 10 through the remainder of the Scenario in association with natural gas production. During this same period, the likelihood of oil spills becomes less and less likely due to the decline of oil production in the Anchor and Satellite fields.

Assuming two drill rigs would operate from each platform, drilling from all production platforms could ensonify eight 1.2 mi (2 km) diameter areas at most before noise returned to background levels. If more than one drill were to be used on each platform, the affected area should not appreciably increase in size, affected bandwidth, or volume since the drills would be operating in very close proximity, and noise levels from each drill should be similar as should the affected frequencies. Not all platforms should be drilling simultaneously; however, 32 wells from 8 platforms would mean an average of 4 wells per platform in Year 25 during the peak of drilling. The noise footprint from this level of drilling would still equate to a 1.4 km (0.9 mi) zone surrounding each production platform where manmade noise might exceed the ambient noise levels for the ocean, mostly at 20 Hz. Due to the small size of the affected area, any sound effects to marine mammals should be negligible. Consequently, the main IPFs to affect marine mammals during the Development and Production Phase of the Scenario would be vessel and aircraft noise/presence, and dredging for pipeline construction.

Oil spill characteristics and effects from small and large refined, crude or condensate spills would be consistent with those described under exploration in (Years 1-5) and development and production (Years 10-25).

In Year 31, the potential for dry gas releases could arise as gas production begins (Section 4.1.2.5). Gas release assumptions include a 20 million cubic foot dry gas release due to a loss of well control, and two 10-20 million cubic foot releases from onshore pipeline ruptures (Section 4.1.2.5; Appendix A). A large gas release from a loss of well control could affect marine mammals in the vicinity of the incident; however, weathering, and the distances between leased areas and most ERAs, GLSs, and LSs, should prevent most marine mammals from being exposed to such events, particularly in winter. Hanna Shoal Area (ERA56) and Chukchi Sea Lead System 4 (ERA 48) are possible exceptions, and a loss of well control in the vicinity of the Hanna Shoal (ERA 6) or Chukchi Sea Lead System 4 (ERA 48) could have effects during winter and spring when bearded, and ringed seals, and some cetaceans are relying on leads and polynyas to access water. If ignition occurs in the vicinity of a ruptured pipeline, or a loss of well control incident, the gas could instantly and explosively combust (Appendix A, Section A-6).

Production and Decommissioning (Years 51-77)

During this period, which features only production activities, up to 168 helicopter flights could occur per week with 1-3 daily flights supporting each production platform. Accidents involving natural gas are most likely to occur between Years 31-74, when natural gas production becomes the primary activity in the Leased Area. Noise production and activities associated with decommissioning offshore platforms, templates, and pipelines, would be consistent with the noises and activities involved in the construction of those same platforms, templates, and pipelines. A potential mitigation that would offset the decommissioning noise and disturbance, would be using the existing platforms, and templates as artificial reefs, such as BOEM has done in other areas in the rigs-to-reefs program. By leaving the rig in place with minor modifications, artificial haulout areas could be produced for pinnipeds, while the vertical structuring provided by the rig could support corals, kelp, and other invertebrates with a solid substrate that is generally lacking in the Chukchi Sea (Russell et al., 2014; Soldal et al., 2002 Todd et al. 2009).

Accidental Oil Spill and Gas Releases

Small and large refined oil, condensate and crude oil spills, and gas releases could occur during the Production and Decommissioning phase of the Scenario, in conjunction with activities such as facility and platform and pipeline decommissioning, and during routine operations. Small and large crude or condensate spills could occur until Year 53, at which time crude oil and condensate production would conclude (Figure 4-2). After Year 53, any accidents would likely include gas releases, large diesel spills from tanks, and small spills of refined oil or fuel that could continue until Year 77. The characteristics and effects from small and large refined, crude or condensate spills and accidental gas releases would be consistent with those described in this section, Exploration (Years 1-5); Exploration, Development, and Production (Years 10-25); Section 4.1.2.5, Tables 4-1 through 4-3, Figure 4-2; and Appendix A.

Effects by Species

Having summarized key oil and gas activities associated with each of the five periods of the Scenario, this section will now analyze how the activities may affect individual marine mammal species in this context.

Oil and gas exploration activities including exploration drilling, seismic surveys, and ancillary activities were conducted within the Leased Area in 1989-1992, and from 2008 to present. Concurrent with oil and gas activities in the Leased Areas, seismic surveys have been conducted by industry, government, and academia throughout most of the Chukchi Sea with no evidence of harm or lingering effects to marine mammals. Individual activities associated with the Scenario do not significanty differ from similar activities that have already been conducted previously. The level of effects to marine mammals from each project have been greatly reduced by the application of the mitigation measures, developed through numerous consultations, that are typically required by NMFS and USFWS in their Biological Opinions, Incidental Harrassment Authorizations, and Incidental Take Statements (see Appendix C, Protected Species Mitigation Measures).

Previous mitigations have included the presence of PSOs onboard industry vessels to detect and avoid marine mammals, shutdown/powerdown procedures for equipment use, protocols for vessels and aircraft to avoid marine mammals, monitoring, and operational modifications intended to mitigate the effects of a project on marine mammals. The existing suite of mitigations were specifically developed by NMFS and the USFWS to prevent incidents of Level A Harassment (MMPA) of marine mammals by industry, and it is reasonable to assume that such mitgations would continue to be applied throughout the life of the Scenario. Additional mitigation recommendations will be incorporated through subsequent Exploration and Development Plans to further lessen the potential level of adverse effects on marine mammals. See Appendix C for a complete description of typical mitigation measures found in BOs, IHAs and ITSs.

Cetaceans

Beluga Whale

Noise production in the Scenario should have negligible effects on beluga whales as should the presence of pipelines, production platforms, aircraft, and construction activities. The single greatest effect from any IPF resulting from the Scenario would be vessel traffic between ports north of Point Lay, Alaska and production platforms during production. With the numbers of vessels anticipated during the production phase, some belugas could be struck and killed by vessels. During summer and much of fall, beluga whales chiefly use deep water areas, on or past the shelf break, and near the ice margins for foraging. For this reason, very few beluga whales would be expected to occur in the Leased Area during the open-water season.

In the Scenario, airgun noise would occur in the initial years, along with noise from localized ancillary activities such as sonar, coring, echosounders, etc. During the exploration phase few if any beluga whales would be affected by actions described within the Scenario. Those in the area would avoid operating airgun arrays and other noise sources even before the visual presence of vessels and surveys became apparent.

In Year 3, operators in the Leased Area would begin drilling exploration wells into the formation, introducing drilling noise into the environment. Exploratory drilling would occur over a 7-year period, during the open-water period when MODUs could be brought on site and used. A second 3-year period of exploration drilling would occur between Years 20 and 22, coinciding with the discovery of the A-2 satellite field. Such operations are unlikely to affect beluga whales, considering the distances between the Leased Area and beluga whale habitat during the open-water season (Clarke et al., 2011, 2012, 2013, 2014).

In Year 6, subsea oil pipeline construction would commence, between a location near Wainwright or Barrow, Alaska, and the site of the first production platform. Forty miles of pipeline would be laid annually over a 4-year period and upon completion, work would begin on the construction of the first production platform in Year 10. Platform construction is expected to take approximately one year to complete, and would be followed by multiple years of production well drilling. Because drilling from production platforms produces much less noise than drilling from drillships, any noise effects on beluga whales would be greatly minimized and restricted to the immediate vicinity of the platform. Between Years 10 and 30, five platforms would be constructed in the Anchor field, approximately five miles apart. At the Satellite field, 20 miles distant from the Anchor field, three more platforms would be built using similar five mi spacing.

The loudest noise associated with production platform construction would be pile-driving to hold the platform in place. Greene and Moore (1995) described decibel levels of 131-135 dB re 1 µPa, at 40 – 100 Hz, extending 1 km (0.62 mi) from the source. Due to ice characteristics in the Chukchi Sea, pilings anchoring production platforms to the sea floor might have to be larger than the pilings used for the Sakhalin platforms, or there could be more pilings used to anchor each platform. If either of these needs arise, the sound propagation characteristics from pile-driving might change. The audibility range for beluga whales is in the 150 Hz – 160 kHz range, starting 50 Hz above the highest sound frequency produced by pile driving for production platforms similar to what could be needed in the Leased Area. Without any likely overlap in noise frequencies and beluga whale audibility range, pile driving should remain inaudible to beluga whales.

Development of the Anchor field would culminate in five production platforms with an additional three platforms installed in the satellite field. The Molikpaq is a mobile Arctic drilling platform, similar in many ways to what would be expected for production platforms in the Leased Area. Thomson and Johnson (1996) documented decibel levels of 112 dB at 1.4 km (0.9 mi) from the Molikpaq, with most of the energy occurring below 20 Hz. Assuming the decibel and frequency levels between the Chukchi Sea and Sea of Okhotsk would be similar, and since 112 dB is approximately at or below ambient noise levels for the Chukchi Sea, the radii for effects should extend to 1.4 km (0.9 mi) or less from each production platform. Not all platforms should be drilling simultaneously; however, 32 wells from 8 platforms would mean an average of 4 wells per platform in Year 25 during the peak of drilling. The noise footprint from this level of drilling would still equate to a 1.4 km (0.9 mi) zone surrounding each production platform where manmade noise might exceed the ambient noise levels for the ocean, mostly at 20 Hz, which is below the accepted auditory bandwidth for beluga whales (150 Hz – 160 kHz). With drilling restricted to two areas having 10 mi diameters, migrating belugas could continue moving and migrating across the Chukchi Sea as needed.

Throughout the 77 years of the Scenario, aircraft traffic, vessel traffic, and some icebreaking/ice-management would continue. Aircraft would be used to conduct crew changeovers with 1-3 daily flights to each production platform during the production phase. The 2011 SEIS 1,500 ft (457 m) minimum altitude requirements (p. 90) would lessen the impact of aircraft on beluga whales to little to no impact (i.e., negligible). Vessel traffic during the production phase would amount to 1-2 weekly trips between the coast and each platform during the open-water season, which should not affect beluga whales with implementation of the existing mitigations prescribed by NMFS through the IHA process are incorporated.

Spills and Belugas. The effects of hydrocarbon exposure on beluga whales are analyzed in the 2007 FEIS, and 2011 SEIS, and the physiological effects of oil spills on beluga whales remains consistent with what was described in those documents. For more detailed information relating to the effects of hydrocarbons on beluga whales refer to the 2007 FEIS, (Section IV.C.1.h(4), pages 156-162).

Small refined or crude oil spills rapidly dissipate volatile toxic compounds within hours to a few days through evaporation and residual components rapidly disperse in open waters. Individual beluga whales could be exposed to small spills, which would have negligible impacts on their health, due to small spills sizes, weathering, and rapid spill dispersal.

Large oil spills and natural gas releases could occur during production; however, the OSRA model indicates very limited chance of contact with resource areas important to beluga whales. Large oil spills in lead systems and in broken sea ice would likely have the greatest effect to beluga whales, but the OSRA model indicates Chukchi Sea lead systems, Kasegaluk Lagoon, and the Barrow Canyon area are not the most likely locations to be affected by large crude oil spills.

Large crude oil spills contacting the Chukchi Sea spring lead system that coincide with large numbers of beluga whales concentrated in the lead system present the greatest potential effects to large numbers of belugas. Likewise, some areas of the Chukchi Sea such as the Kasegaluk Lagoon Area (ERA 1) host relatively large groups of feeding and molting beluga whales. If a large crude oil spill contacted a significant portion of such groups, the effects could be greater than would generally occur in the Chukchi Sea, and might affect the population. Such incidents could produce effects if large numbers of females and calves were contacted by crude oil. In such an event, individuals or groups could be injured or killed, leading to a moderate impact. Spill response activities could also produce short-term changes in local distribution and abundance, which would have a negligible impact. For large crude oil spills in open water areas and away from any ERAs, the impacts to beluga whales should remain negligible. A moderate impact could occur only if the majority of a large crude oil spill from PL 6 were to contact Kasegaluk Lagoon (ERA 1) during summer, and in the absence of spill response efforts. Natural weathering and dispersal of a large crude oil spill over 30 days would mostly prevent beluga whales from encountering any substantially large patches of crude oil. Consequently, some beluga whales could encounter patches of crude oil from time to time, which would have negligible to minor effects though large numbers of belugas should not be affected. Due to the patchiness of a large crude oil spill at 30 days, and dispersal over a large area, concentration areas such as Kasegaluk Lagoon (ERA 1) would mostly likely have patches of crude oil occurring in widely scattered pockets with most of the oil eventually washing ashore. For this reason, portions of Kasegaluk Lagoon inside the barrier islands where belugas and spotted seals aggregate should remain mostly free from oiling. The ensuing impacts from large crude oil, condensate, or diesel spills would mostly remain negligible, unless concentration areas are oiled. If concentration areas were to become contacted with oil the impacts would likely be minor. Some belugas could experience injury or mortality as a result of prolonged exposure to freshly spilled oil; however, the number of individuals that could be affected is expected to remain small. Some individual whales could experience skin contact with oil, inhalation of hydrocarbon vapors, localized reduction in prey sources, consumption of petroleum and/or petroleum-contaminated food items, perhaps temporary displacement from feeding/resting areas, and temporary interruption of migration timing and route.

Crude oil exposure on whales could have lethal effects on a few individuals; however, most individuals exposed to spilled oil would experience minor physiological effects.

Impacts. Marine seismic surveys, geohazard and geotechnical surveys, drilling, vessel and aircraft traffic, vessel and aircraft noise, dredging, and piledriving, would have little to no impacts (i.e., negligible) on beluga whales in and around the Leased Area because the acoustic frequencies involved are below documented beluga whale hearing thresholds, and because most beluga whales would be north of the Leased Area, making noise from the Leased Area insufficient to create measureable effects to this species. Noises from icebreaking and ice-management activities could elicit some behavioral responses from belugas; otherwise, vessels would have little effect on belugas due to the low numbers of belugas in the Leased Area when exploration and development activities would occur, and the negligible effects production would have on them. Vessel traffic could have the greatest effect on belugas; however, they should be capable of avoiding vessels if necessary and the low numbers of belugas in the Leased Area, plus NMFS mitigations would make effects negligible to minor. Small spills and condensate releases would have negligible effects on beluga whales. Large crude oil, condensate, or fuel spills could have a minor effect on beluga whales, because impacts would be short-term and localized, but only if a large crude oil spill were to occur during summer and allowed to contact concentration areas and if containment and cleanup responses were not implemented or were not effective. The impacts from large crude oil spills would otherwise be negligible.

Bowhead Whale (Endangered)

Noise production would have minor and negligible effects on bowheads and only during the open-water season (Jul-Oct); however, the levels of vessel traffic expected during the production phase could increase the likelihood of vessel-whale collisions (George et al., 1994). Vessel collisions with whales often lead to the death of the whale that was struck, and any such incidents would equate to a moderate impact on bowhead whales. Though most bowhead whales spend their summers in the eastern Beaufort Sea and near Barrow Canyon upwellings in the western Beaufort Sea, a few may occur in the Leased Area during summer. Starting in September, the majority of bowhead whales begin migrating from the Beaufort Sea, and across the Chukchi Sea, with their fall migration route passing through the Leased Area. By the end of October, most bowhead whales would be in the Chukchi Sea feeding near upwellings along the northern coast of Chukotka and later in the Gulf of Anadyr. Consequently, the preponderance of bowhead whales would be in the Beaufort Sea until late September when they begin migrating across the Chukchi Sea to Chukotka, placing them out of the Leased Area until late September through October. During the fall migration, with no mitigation in place, vessel strikes to bowhead whales would be likely, particularly during production when numerous vessels per week are expected to travel between the Leased Area and the coast. Considering the seasonal distribution of bowhead whales in the Chukchi Sea, vessel strikes to bowheads would most likely occur during the September-October fall migration, potentially killing a few whales, resulting in a moderate level of effect. As the bowhead whale stock increases in number, so too would the likelihood of vessel strikes throughout the year if no mitigations are in place to protect this species. Note that the level of effect is determined to be moderate only because bowhead whales are listed as an endangered species; vessel strikes and any associated injury or mortality could not result in population-level effects on the species. Nonetheless, the use of PSOs, and speed limits for vessels as mitigating measures should reduce the likelihood of fatal vessel strikes to bowhead whales.

As stated in the Beluga section, marine seismic noise would occur in the initial years of the Scenario and give way to the noise from highly localized ancillary activities. Marine seismic surveys should affect very few bowhead whales in the Leased Area until mid to late September when large migration pulses of bowheads begin leaving the Beaufort Sea, traveling through the Leased Area to feeding grounds off the northern coast of Chukotka. Seismic operations during this time frame have the potential to affect much of the bowhead whale population within the Western Arctic Stock by eliciting avoidance reactions in whales. A small number of whales in the Leased Area during summer months would avoid areas of active airgun arrays by a margin of several miles, depending on airgun array size, source levels, sound propagation characteristics, and the activity that whales are engaged in at the time they perceive airgun noise. Migrating bowhead whales would briefly divert around active seismic surveys before resuming travel on their migration route. Seven marine seismic surveys are to be expected in Years 1, 8, 11, 15, 19, 21, and 25; along with 12 Geohazard and 12 Geotechnical Surveys during Years 1-23. The small scale of the Geohazard and Geotechnical surveys, the equipment used, and the few marine seismic surveys would not interact to produce anything beyond temporary, brief avoidance behavior by bowhead whales.

The exploratory drilling that begins in Year 3 of the Scenario, (as described in the Beluga section), would occur over a 7-year period, during the open-water period when MODUs could be brought to the drilling site. Such operations could affect bowhead whales since broadband source levels from the Shell drillship *Discoverer* ranged from 177 to 185 dB re 1 μPa rms during Chukchi Sea drilling activities in 2012 (Shell, 2011a), and jack-up rigs are assumed to produce lower noise levels than drillships (NMFS, 2013b). Koski and Johnson (1987) concluded the area of effects for exploratory drilling noise would radiate approximately 12.4+ mi (20+ km) from an operating drillship. The limited number of exploration wells, 4 per year in Years 3-9 and 20-22, would affect very few bowhead whales before the fall migration. During the fall bowhead whale migration, exploratory drilling would likely cause whales to divert around areas where drilling was occurring with avoidance distances of at least 12.4 miles, which represents the potential area of effects (Koski and Johnson, 1987).

Because drilling from production platforms produces much less noise than drilling from drillships, noise effects on bowheads would be reduced and restricted to the immediate vicinity of the platform. Between Years 10 and 30, approximately 8 platforms would be constructed in the Anchor field, at distances approximately 5 miles apart, with a 20 mi distance from the Anchor field to the Satellite field where 3 more platforms would be built using similar 5 mi spacing.

Pipeline construction would begin in year 6 and run through Year 9, when platform consctruction would begin. The noises from dredgeing sub-sea pipelines would be around 110 dB at 20-700 Hz, which is at the low end of the 5 Hz – 30 kHz audibility range of low-frequency cetaceans such as bowhead whales (Table 4-44). During construction of an offshore artificial island in the Beaufort Sea in 1980, bowhead whales approached to within 800 m of operating suction dredges that were producing noise in excess of 120 dB re 1 µPa at 1.2 km from the noise source (Richardson 1995). In a subsequent study (Richardson et al. 1990) bowhead whales relocated from within 0.8 km to > 2 km from an operating dredge when noise levels were 122-131 dB re 1 µPa or 21-30 dB re 1 µPa above ambient noise levels (Richardson 1995). The limited responses of bowhead whales to operating dredges suggests they would react to dredging and pipeline installation by adjusting their distance from the noise source with a 0.8-2+ km avoidance buffer, with negligible to minor effects on the bowhead whales from dredging.

The loudest noise associated with production platform construction would be pile-driving, with Greene and Moore (1995) noting pile-driving noise levels of 131-135 dB re 1 µPa (40 – 100 Hz) at 1 km (0.62 mi) from the source. Due to ice characteristics in the Chukchi Sea, production platforms in the Chukchi Sea may require larger pilings than used for the Sakhalin platforms, or more pilings to anchor each platform to the sea floor. In either situation, pile-driving sound propagation characteristics could change. The audibility range for bowhead whales occurs within a 5 Hz – 30 kHz range (Ciminello et al., 2012), overlapping the 100 Hz - 2 kHz frequency noise range produced by pile driving. Since pile driving noise source levels from Cook Inlet, Alaska (Blackwell, 2005) were 190 dB re 1 µPa, and rapidly attenuated to 115-133 dB re 1 µPa within one km (0.62 mi) it is assumed similar attenuation of pile driving noise would occur in the Leased Area. Though there is overlap in the noise frequencies affected by pile-driving and the noise frequencies used by bowhead whales, the overlap occurs at the bottom of the audibility spectrum for bowheads. Furthermore, it is generally assumed that mysticete whales, including bowheads, would refrain from approaching noises loud enough to produce a PTS or TTS since mammals instinctively avoid injury under most situations. Pile driving could occur during the open-water season when most bowhead whales are feeding in the Beaufort Sea, and when bowheads pass through the Leased Area during their fall migration. With audible noise levels slightly above those of ambient noise within a km (0.62 mi) of pile-driving activity, the effects of pile driving should include behavioral responses such as slight shifts in individual bowhead migration trajectories to avoid approaching the noises and activity. No PTS, TTS, or other physiological responses should occur because of pile-driving or other construction ativiites, dredging, or pipeline construction.

The end result of the Scenario field development methodology would be a total of eight production platforms installed in the Satellite and Anchor fields. The Molikpaq is a mobile Arctic drilling platform, similar in many ways to what would be expected for production platforms in the Leased

Area. Thomson and Johnson (1996) documented decibel levels of 112 dB at 1.4 km (0.9 mi) from the Molikpaq, with most of the energy occurring below 20 Hz. Assuming the decibel and frequency levels between the Chukchi Sea and Sea of Okhotsk are similar, and since 112 dB is approximately at or below ambient noise levels for the Chukchi Sea, the radii for effects should extend to 1.4 km (0.9 mi) or less from each production platform. Not all platforms would be drilling simultaneously; however, the noise production from drilling 32 wells from 8 platforms would average 4 wells per platform in Year 25 during the peak of drilling activity. The noise footprint from this level of drilling would amount to a 1.4 km (0.9 mi) zone surrounding each production platform where manmade noise might exceed the ambient noise levels for the ocean, mostly at 20 Hz which is within the very bottom range of the auditory bandwidth for bowhead whales (5 Hz – 30 kHz). With drilling restricted to two 10 mi diameter areas, migrating bowheads should continue moving and migrating across the Chukchi Sea as needed, diverting around locations where drilling is occurring by 1.4 km (0.9 mi). Once drilling is completed, bowhead whales should eventually habituate to the presence of production wells potentially passing near areas of active production platforms without effects (Aerts and Richardson, 2010; McDonald, Richardson, Kim and Blackwell, 2010).

Subsea wells would be drilled by MODUs, and the effects of such activity would be similar to the effects of drilling exploration wells. Such activity would occur between Years 12 – 23 with a maximum of 9 wells drilled in a single season. Throughout the 77 years of the Scenario, aircraft traffic, vessel traffic, and some icebreaking/ice-management would continue. Aircraft would be used to conduct crew changeovers with 1-3 daily flights to each production platform during the production phase. The 1,500 ft (457 m) minimum altitude requirements would lessen the effects of aircraft on bowhead whales to negligible levels (2007 FEIS, p. 90). Vessel traffic during the production phase would amount to 1-2 weekly trips between the coast and each platform during the open-water season, which should not affect bowhead whales if the NMFS (2013b) mitigations are incorporated and PSOs are kept onboard vessels. Without a PSO presence on vessels, there is an increased probability of vessel strikes to bowhead whales during the fall bowhead migration. Reducing vessel speeds below 10 knots would be an additional mitigation that would further lessen chances of vessel strikes to bowhead whales by providing vessels more reaction time to avoid strikes; providing whales with more time to avoid vessels; and lessening the potential impact force and trauma severity to whales. This measure has been used successfully to protect north Atlantic right whales, a species anatomically and mechanistically very similar to bowheads (Vanderlaan and Taggart, 2007; 79 FR 34245 (June 16, 2014); Silber and Bettridge, 2012).

Spills and Bowheads. The effects of hydrocarbon exposure on bowhead whales are analyzed in the 2007 FEIS, and 2011 SEIS, and the Biological Opinion (NMFS, 2013b), and the physiological effects of oil spills on bowhead whales remains consistent with what was described in those documents. For more detailed information relating to the effects of hydrocarbons on bowhead whales refer to the 2007 FEIS (Section IV.C.1.f(1)(g)3), pages IV 116-121), and the NMFS 2013 Biological Opinion (Sections 2.4.2.4.1, 2.4.3.4., and 2.4.5.4.1.).

Small refined or crude oil spills rapidly dissipate volatile toxic compounds within hours to a few days through evaporation and residual components rapidly disperse in open waters. Individual bowhead whales could be exposed to small spills, which would have negligible effects on their health, due to small spills sizes, weathering, and rapid spill dispersal.

Large oil spills and condensate releases could occur during development or production, and likewise for condensate releases; however, the OSRA model indicates limited chances of contact with resource areas important to bowhead whales.

Large oils spills contacting the spring lead systems such as Chukchi Sea Spring Lead 2 (ERA 53), and Chukchi Sea Spring Lead 3 (ERA 54); and around Pt Lay-Barrow BH GW SFF (ERA 61), or during the September – October fall migration of bowhead whales would likely have the greatest effect on bowhead whales. The OSRA model indicates Chukchi Sea lead systems, Kasegaluk Lagoon, and the Point Lay-Barrow BH GW SFF (ERA 61) are the most likely ERAs to be contacted by large crude oil spills.

Assuming a 1 mm thickness, and a large crude oil spill volume of 3,162 bbl (5,100 bbl after a 30 day high-end post weathering estimate using information from Table 4-3), a large crude oil spill could continuously cover a 14 mi x 14 mi area. Currents and weather would break and disperse such a spill across a much larger area after 30 days, making it unlikely individual marine mammals, including migrating bowhead whales, would experience continuous or prolonged exposure. Thus whales and other marine mammals could encounter some crude oil from a large spill; however, the quantities they would encounter would mostly be small and infrequent after 30 days and should result in minor transient effects to bowheads. Oil spill containment and cleanup would reduce the spill volume, and its ability to spread, further reducing the range of impacts to negligible-minor.

A large oil spill could result in some individual bowhead whales coming into contact with oil, potentially resulting in inhalation of hydrocarbon vapors, baleen fouling, and ingestion of contaminated prey. In addition, localized reduction of bowhead whale prey could occur, including long term impacts if hydrocarbons entered the benthos. Temporary displacement from feeding and resting areas, and temporary alterations to migration timing and route could also occur.

If an oil spill were to cause extensive mortality within a high latitude amphipod population with low fecundity and long generation times, a marked decrease in secondary production could ensue in some areas (Highsmith and Coyle, 1992). Such effects would not persist in upwelling areas that receive pelagic invertebrate inputs from the Bering Sea and Arctic Ocean (Chukotka Upwelling, Barrow Canyon, etc.).

Impacts. Collectively, the IPFs in the Scenario would have negligible effects on bowhead whales in the Leased Area since most bowheads would be in the Beaufort Sea until mid-September to mid-October. During the fall, bowheads migrate through the area; however, activities in the development, production, and decommissioning of OCS infrastructure on the Leased Area should have few observable effects on whales. The interaction of marine seismic surveys, geohazard surveys, geotechnical surveys, pile driving, drilling from MODUs, and aircraft traffic would have short-term, localized impacts (minor) on bowheads during the exploration and development phase of the Scenario. Though the noise levels from airguns, dredging, and pile driving could produce short-term and localized, and thus minor impacts on bowheads, mitigations required (see Appendix C) by NMFS (2013b) would reduce the impacts to negligible levels on bowhead whales. Small oil spills would have negligible effects on bowhead whales due to their small volume, rapid weathering, and rapid dispersal. Large crude oil or condensate spills would likely have negligible to minor effects on bowhead whales during summer; however, such spills could have moderate to major effects if most of a large spill were to contact a spring lead system, feeding areas such as occurs near Barrow Canyon, or occurred during the fall migration as bowheads migrate through and around the Leased Area. Prompt spill responses, NMFS mitigations, weathering of the oil, and having smaller volumes of oil reaching important areas would reduce the level of effects to negligligible-minor, unless a spring lead system is contacted by a large proportion of a large oil spill. In such a situation, the effects would be moderate; however; execution of a spill response and implementation of NMFS mitigations would reduce the effects to minor- moderate.

The IPF having the greatest potential to harm individual bowhead whales is vessel traffic, which could result in a moderate impact because impacts could be long-lasting and widespread, but less than severe. Considering the levels of vessel traffic in the Scenario, some mortalities would be likely, particularly during the spring and fall migrations when all of the bowhead whale stock passes between the Leased Area and the Alaskan coast, and during the development and production phases of operations when vessel traffic levels would be greatest. By reducing transiting and operating vessel speed below 10 knots as described for north Atlantic right whales in 50 CFR 224.105, the risk of a vessel strike to bowhead whales should be further reduced, which would lead to negligible levels (Vanderlaan and Taggart, 2007; 79 FR 34245 (June 16, 2014); Silber and Bettridge, 2012). Though mortalities would be unlikely to occur in any given year of the Scenario, over the life of the Scenario, the probability of such an incident occurring would be much more likely, though no population level effects would occur.

Gray Whale

Gray whales occur in the Leased Area and Chukchi Sea coastal waters during summer, where they feed and rear their calves. Coastal areas have an extremely low likelihood of being affected by any impact producing factors associated with the Scenario due to the distances between these habitats and the Leased Area except for vessel traffic and pipeline construction.

Annually, about three gray whales are killed inadvertently by the commercial fishing industry, an average of 2.2 by vessel strikes that are reported, and 123 by subsistence whaling. Though Alaska Natives do not habitually pursue gray whales for subsistence, the Makah Tribe (Neah Bay, Washington) takes four whales annually, while Chukotkans (Russia) take the remaining 118 or so annually (Carretta et al., 2013).

The effects of vessel traffic could be mitigated with speed limits below 10 knots, which would greatly reduce the probability of ship strikes to whales. If vessel traffic, and particularly vessel traffic between the coast and Leased Area, does not reduce speed, the likelihood of vessel strikes to gray whales would become much more likely, even with other NMFS-mandated mitigations such as PSOs, particularly in the vicinity of Peard Bay and Barrow, Alaska. During the production phase, numerous vessels moving in these areas could result in some gray whale stikes. The increased potential for vessel strikes is due to the large numbers of gray whales in coastal waters, and increased levels of vessel traffic. By conducting pipeline construction operations, including dredging, at times when gray whales are absent from the pipeline area, or by directing pipelines to landfall areas away from gray whale concentration areas, the effects of pipeline construction could be mitigated to negligible levels of effect.

Spills and Gray Whales. The effects of hydrocarbon exposure on gray whales are analyzed in the 2007 FEIS and 2011 SEIS, and the physiological effects of oil spills on gray whales remains consistent with what was described in those documents. For more detailed information relating to the effects of hydrocarbons on gray whales refer to the 2007 FEIS, (Section IV.C.1.h(4), pp. IV 157-162).

During fall, gray whales migrate south along coastal routes to their wintering grounds in the Sea of Cortez, and this migration route takes gray whales through offshore oil and gas developments with production platforms that have been operating since the 1950s and 1960s and through areas that naturally leak oil into the ocean (Hornafius, Quigley, and Luyendyk, 1999; Moore and Clarke 2002). Exposure to oil in such areas is a part of the natural condition for gray whales, indicating they have some ability to tolerate, adjust to, or avoid crude oil in nearshore areas.

Small refined or crude oil spills rapidly dissipate volatile toxic compounds within hours to a few days through evaporation and residual components rapidly disperse in open waters. Individual gray whales could be exposed to small spills, which would have negligible effects on their health, due to small spills sizes, weathering, and rapid spill dispersal.

Large spills of crude oil or condensate or diesel are estimated to occur. In the event of a large oil spill, some individual gray whales could be temporarily injured, and a small number of those could die if exposed to oil for prolonged periods. Temporary physiological effects could arise from skin contact with oil, baleen fouling, hydrocarbon vapor inhalation, and localized prey reduction, petroleum consumption, consumption of contaminated prey, brief displacement from feeding/resting areas, and interruption of migration timing and routes.

Dispersants used on oil eventually sink to the bottom with oil molecules, and affect benthic prey species, which may be detrimental to gray whales, particularly in feeding areas (Würsig, 1990; Moore and Clarke, 2002). Bottom muds could also be contaminated in the same manner, and ingested by gray whales. Perturbation, such as an oil spill, which caused extensive mortality within a high latitude amphipod population with low fecundity and long generation times would result in a marked decrease in secondary production (Highsmith and Coyle, 1992).

Some gray whales could experience injury or mortality as a result of prolonged exposure to freshly spilled oil; however, the number affected likely would be small. Some individual whales could experience skin contact with oil, baleen fouling, inhalation of hydrocarbon vapors, localized reduction in prey sources, consumption of petroleum and/or petroleum-contaminated food items, perhaps temporary displacement from feeding/resting areas, and temporary interruption of migration timing and route. Spilled oil, if chemical dispersants are used to break up surface oil and cause it to sink to the bottom, could negatively affect gray whales by contaminating benthic prey, particularly in primary feeding areas (Würsig, 1990; Moore and Clarke, 2002). Bottom muds could be contaminated and oil deposited on the bottom could be ingested by feeding gray whales. Perturbation, such as an oil spill, which caused extensive mortality within a high latitude amphipod population with low fecundity and long generation times would result in a marked, though temporary, decrease in secondary production (Highsmith and Coyle, 1992). Effects of exposure of whales to spilled oil may include, but are not anticipated to result in, lethal effects to a few individuals, and most individuals exposed to spilled oil likely would experience minor impacts.

Prolonged exposure of gray whales to large crude oil or condensate spills could result in lethal effects to a few individuals; however, such an outcome is not expected. Gray whales regularly migrate through one of the largest known naturally occurring oil seeps in the world off the California coast near Santa Barbara (Hornafius et al., 1999), and have done so for millennia, indicating they have the ability to either detect and avoid, or tolerate, some crude oil in their environment. Because crude oil would weather, and disperse, the effects of a large crude oil, diesel, or condensate spill are expected to be minor.

Impacts. The greatest effects would occur from a nearshore pipeline rupture spilling crude oil or condensate into the Peard Bay region where many gray whales concentrate to feed. If a nearshore pipeline were to rupture, impacts would be minor because a large crude oil or condensate spill in the vicinity of Pt Lay-Barrow BH GW SFF (ERA 61) would weather, the pipepline would cease pumping oil or condensate, and because gray whales should be able to mostly avoid an oil spill. Otherwise, the impacts of the Scenario on gray whales would be short-term and localized, and thus minor if, previously described NMFS mitigations are incorporated. These mitigation measures include the use of PSOs, (which would help vessel operators detect and avoid gray whales), and lower vessel speeds within the Leased Area and from the Leased Area to the Alaskan coastline. Without such mitigations it is safe to assume moderate effects would occur due to the increased chance of a gray whale being struck by a vessel, and the greater numbers of gray whales being exposed to anthropogenic noise in the environment.

Fin Whale (Endangered)

Fin whales may be found throughout the OCS of the Chukchi Sea during the open-water season; however, the numbers of individuals detected has always been very low. Though fin whales differ from bowhead whales in many ways, the assumption is that their auditory abilities, sensitivities, behavior, and physiology is close enough to bowhead whales that the effects analysis for bowhead whales is applicable to fin whales.

Spills and Fin Whales. The effects of hydrocarbon exposure on fin whales are analyzed in the 2007 FEIS and 2011 SEIS, and the NMFS 2013 Biological Opinion (NMFS, 2013b), and the physiological effects of oil spills on fin whales remains consistent with what was described in those documents. For more detailed information relating to the effects of hydrocarbons on fin whales refer to the 2007 FEIS (Section IV.C.1.f(1)(g)3), pages IV 116-122), and NMFS 2013 Biological Opinion (Sections 2.4.2.1.2., 2.4.2.4.2., and 2.4.5.4.2.).

Small refined or crude oil spills rapidly dissipate volatile toxic compounds within hours to a few days through evaporation, and residual components rapidly disperse in open waters. Individual fin whales could be exposed to small spills, which would have negligible impacts due to small spills sizes, weathering, and rapid spill dispersal. Fin whales are few in the Chukchi Sea and the likelihood of any fin whale encountering a large crude oil or condensate spill is low. The physiological effects of contact with crude oil on fin whales would be similar to what was described for other baleen whales. Because of their scarcity in the Chukchi Sea and the fact that existing observations show fin whales mostly in the southern Chukchi Sea, large crude oil, or condensate releases should have negligible effects on fin whales.

Impacts. The effects of most IPFS in the Scenario on fin whales would be consistent with those for bowhead whales which were mostly negligible if mitigated. Though a large oil or condensate spill minor or moderate effects on bowhead whales, such an event would have negligible effects on fin whales due to their scarcity, particularly in the northern Chukchi Sea, and their seasonal use of the Chukchi Sea. The low numbers of fin whales believed to use the Chukchi Sea preclude any population-level effects to their stocks from of any of the IPFs occurring within the Leased Area in the Scenario. For these reasons the IPFs in the Scenario should have negligible impacts on fin whales.

Harbor Porpoise

Harbor porpoises may occur throughout the Chukchi Sea during the open-water season, and some are likely to be in the Leased Area. They hear in the high-frequency bands, making seismic noise and large vessel operations mostly inaudible to them. In the Scenario, seismic noise would occur in the initial years, giving way to the noise from highly localized ancillary activities such as sonar, coring, echosounders, etc. Sonar noise could affect harbor porpoises, though the sonar noise produced during ancillary activities is directed to a narrow area on the sea floor.

During the exploration phase some harbor porpoises could be affected by actions described within the Scenario, and individuals in the area should avoid detectable noise sources, and noisy areas before the visual presence of vessels and surveys become apparent. Richardson (1995) noted odontocetes generally habituate well to the presence of drilling and production wells. Bach, Skov, and Piper (2010) confirmed offshore platforms and drilling activities pose no threat to small harbor seals or other small cetaceans, while production platforms may increase the presence of prey items by serving as artificial reefs. Exploratory drilling would occur in Years 3-23, production wells and platforms would be constructed between Years 10-34, and subsea wells between Years 12-23.

As described in the Beluga section, the loudest noise associated with production platform construction would be pile-driving to anchor the platform to the seabed. Greene and Moore (1995) described decibel levels of 131-135 dB re 1 µPa, at 40 – 100 Hz, extending 1 km (0.62 mi) from the source. Due to ice characteristics in the Chukchi Sea, pilings anchoring production platforms to the sea floor might have to be larger, or there could be more pilings used to anchor each platform. If either of these needs arise, the sound propagation characteristics from pile-driving might change. The audibility range for harbor porpoises is in the 100 Hz – 200 kHz range, starting at the highest sound frequency produced by pile driving for production platforms. Without much overlap in drilling, pile-driving and construction noise frequencies and harbor porpoise audibility range, pile driving should remain mostly inaudible to harbor porpoises.

Pipline construction would begin in year 6 and run through year 10, when platform construction would begin. Dredging activities associated with laying in subsea pipelines produce noises above ambient levels (~110 dB) at frequencies of 20 Hz – 700 Hz, and within the 100 Hz- 200 kHz audibility range for harbor porpoises (Greene and Moore, 1995). Thomson and Johnson (1996) documented decibel levels of 112 dB at 1.4 km (0.9 mi) from the Molikpaq, with most of the energy occurring below 20 Hz, far below the accepted auditory bandwidth for harbor porpoises (100 Hz – 200 kHz). Considering past observations in other areas where harbor porpoises have deliberately closely approached offshore drilling, construction, and platforms, the unmitigated effects of these IPFs on harbor porpoises should be negligible.

Vessel traffic would occur regularly in support of operations on the OCS, as would icebreaking/ice management throughout the 77-year life of the Scenario. Aircraft would be the likeliest means of conducting crew changeovers with 1-3 daily flights to production platforms during production. Assuming minimum altitude requirements of 1,000 to 1500 ft (305-457 m) ASL/AGL are applied in the Scenario, the effects of aircraft on harbor porpoises should be negligible. Similarly, vessel traffic during production would amount to 1-2 weekly trips between the coast and each production platform during the open-water season, which should have negligible effects on harbor porpoises if existing mitigations from Lease Sale 193 are incorporated.

Spills and Harbor Porpoises. The effects of hydrocarbon exposure on harbor porpoises are analyzed in the 2007 FEIS and 2011 SEIS, and the physiological effects of oil spills on them remains consistent with what was described in those documents. For more detailed information relating to the effects of hydrocarbons on harbor porpoises refer to the 2007 FEIS, (Section IV.C.1.h(4) (pages IV 156-162)).

Small refined or crude oil spills rapidly dissipate volatile toxic compounds within hours to a few days through evaporation, and residual components rapidly disperse in open waters. Individual harbor porpoises could be exposed to small spills, which would have negligible effects on their health, due to small spills sizes, weathering, and rapid spill dispersal.

In the event of a large crude oil or condensate spill, some harbor porpoises could be affected; however, harbor porpoise numbers and distribution in the Chukchi Sea are believed to be low and widely distributed, mostly in areas of the Chukchi Sea south of Point Hope and Cape Lisburne, Alaska. Though no ERAs were identifiable for harbor porpoises, a safe assumption would be that a large oil spill or condensate spill would affect a small number of them, most likely less than 100 over the duration of the spill, and only in the absence of a spill response. Such effects could lead to the deaths of a portion of the affected porpoises, which would equate to potential moderate impacts to harbor porpoises from large oil spills.

Oil spills would most likely occur during exploration or oil production drilling, and would likely include a mix of oil and condensate. Fuel spills could occur at any time during the Scenario, and would most likely be the result of refueling accidents at sea. Fuel spills should have no effect on harbor porpoises because of the small spill size, and relatively small area contacted with oil.

Impacts. Collectively, most of the IPFs in the Scenario would have negligible (little or no) impacts on harbor porpoises in the Leased Area if the mitigations described for beluga whales are implemented for harbor porpoises. In the absence of such mitigations, some harbor porpoises could inadvertently be exposed to anthropogenic noises that could have minor levels of effect on the species since no safeguards protecting harbor porpoises from anthropogenic noise production would exist. Dredging could produce loud noises lasting for several weeks; however, harbor porpoises would likely avoid areas with noise levels sufficient to produce injury to the high-frequency cetacean group.

Humpback Whale (Endangered)

A few humpback whales have been observed in coastal areas of the southern Chukchi Sea during the open-water season, but could occur in other areas of the Chukchi Sea in very low numbers. Humpback whales differ from bowhead whales in many ways; however, their auditory abilities, sensitivities, behavior, and physiology are considered close enough to that of bowhead whales that the effects analysis for bowhead whales is applicable to humpback whales.

Spills and Humpbacks. The effects of hydrocarbon exposure on humpback whales are analyzed in the 2007 FEIS, and 2011 SEIS, and the Biological Opinion (NMFS, 2013b), and the physiological effects of oil spills on humpback whales remains consistent with what was described in those documents. For more detailed information relating to the effects of hydrocarbons on humpback whales refer to the 2007 FEIS (Section IV.C.1.f(1)(g)3) (pages IV 116-122)), and NMFS 2013 Biological Opinion (Sections 2.4.2.4.3., 2.4.3.4., and 2.4.5.4.3). Small refined or crude oil spills rapidly dissipate volatile toxic compounds within hours to a few days through evaporation and residual components rapidly disperse in open waters. Individual humpback whales could be exposed to small spills, which would have negligible effects on their health, due to small spills sizes, weathering, and rapid spill dispersal.

Concentration areas for humpback whales include a June-September aggregation area at Pt Hope Offshore (ERA 107), and a May-October feeding area at RusCH C Dezhnev (BS 2) (Table A.1-11, and Maps A-2f and A-1), with annual contact chances <5% at 30 and 360 days (Tables A.2-21 and A.2-24). The effects of large crude oil or condensate spills, or natural gas releases would be similar to what was described for bowhead whales.

Impacts. The effects of most IPFS in the Scenario on humpback whales would be consistent with those for bowhead whales: mostly negligible. Though a large oil, or condensate spill could have minor or moderate effects on bowhead whales, such an event would have negligible effects on humpaback whales due to their scarcity in the Chukchi Sea, particularly the northern Chukchi Sea, and their seasonal presence in the Chukchi Sea. Humpback whales use nearshore habitat and have been observed in Peard Bay near potential landfall locations for offshore oil and gas pipelines. The low numbers of humpback whales believed to use the Chukchi Sea preclude any population-level effects to their stocks from of any of the IPFs occurring within the Leased Area in the Scenario. For these reasons, the IPFs in the Scenario should have negligible impacts on humpback whales.

Killer Whale

Killer whales have been seen in low numbers in the Chukchi Sea during the open-water season in recent years (Allen and Angliss, 2013). These individuals are believed to be part of a transient stock that primarily hunts other marine mammals and for this reason are expected to use areas with higher marine mammal concentrations, particularly seals, belugas, and gray whales. Unlike seals and belugas they usually avoid areas of sea ice concentrations, making much of the northern Chukchi Sea unavailable for their use.

Killer whales have mid-frequency hearing, similar to that of beluga whales, and heavily rely on sonar and echolocation to feed and navigate. Consequently, their shared similarities indicate the effects analyses for beluga whales would also apply to killer whales. Unlike beluga whales, the numbers of killer whales in the Chukchi Sea are believed to be low, precluding the possibility of population-level effects to killer whales from any of the IPFs occurring within the Leased Area.

Spills and Killer Whales. The effects of hydrocarbon exposure on killer whales are analyzed in the 2007 FEIS and 2011 SEIS, and the physiological effects of oil spills on them remains consistent with what was described in those documents. For more detailed information relating to the effects of hydrocarbons on killer whales refer to the 2007 FEIS (Section IV.C.1.h(4) (pages IV-56 – 162).

Impacts to Killer whales from small spills are similar to those described for humpback whales. Small refined or crude oil spills rapidly dissipate volatile toxic compounds within hours to a few days through evaporation and residual components rapidly disperse in open waters. Individual killer whales could be exposed to small spills, which would have negligible effects on their health, due to small spills sizes, weathering, and rapid spill dispersal.

Impacts. Collectively, the effects of most IPFS in the Scenario on killer whales would be consistent with those for belugas and harbor porpoises which were mostly negligible. Noise associated with the Scenario would mostly occur outside the audible bandwidth for killer whales, making it inaudible to mid-frequency cetaceans. As such, the impacts of noise on killer whales should be negligible. Though a large oil or condensate spill could have minor or moderate effects on beluga whales, such an event would have negligible effects on killer whales due to their scarcity, particularly in the northern Chukchi Sea, their seasonal use of the Chukchi Sea, and the lack of any concentration areas as occurs with beluga whales. The low numbers of killer whales believed to use the Chukchi Sea preclude any population-level effects to their stocks from of any of the IPFs occurring within the Leased Area in the Scenario. For these reasons the IPFs in the Scenario should have negligible impacts on killer whales.

Minke Whale

Minke whales may be found throughout the OCS of the Chukchi Sea during the open-water season; however, the numbers of individuals detected have consistently been low. Minke whales differ from bowhead whales in many ways, but their auditory abilities, sensitivities, and behavior remains similar enough to bowhead whales that the effects analysis for bowhead whales is applicable to minke whales.

The effects of hydrocarbon exposure on minke whales are analyzed in the 2007 FEIS, and 2011 SEIS, and the physiological effects of oil spills on them remains consistent with what was described in those documents. For more detailed information relating to the effects of hydrocarbons on minke whales, refer to the 2007 FEIS (Section IV.C.1.h(4), pages IV-156 – 162).

Small refined or crude oil spills rapidly dissipate volatile toxic compounds within hours to a few days through evaporation, and residual components rapidly disperse in open waters. Individual minke whales could be exposed to small spills, which would have negligible effects on their health, due to small spills sizes, weathering, and rapid spill dispersal.

Impacts. The Scenario should have negligible overall impacts on minke whales, and the effects of noise should be similar to what was described for other baleen whales. Small spills should produce no effects on minke whales. Large crude oil or condensate spills, or gas releases could affect minke whales; however, the scarcity of minke whales in the Chukchi Sea and Leased Area suggests minke whales would remain mostly unaffected by large spills or gas releases. For this reason the impacts of the Scenario on minke whales would be negligible.

Ice Seals

Bearded Seal

Collectively, most IPFs in the Scenario would have negligible effects on bearded seals in the Leased Area since most of them would be widely dispersed in sea ice, or in the Bering Sea during winter months. The noise levels from airguns, dredging, and pile driving would be sufficient to produce very limited effects on seals, amounting to avoidance behavior; however, if the mitigations required in the NMFS Biological Opinion (2013b) are followed, it would reduce the impacts to negligible levels of effects on bearded seals while ensuring no Level A Harassment or Takes of bearded seals occur.

Scenario activities occurring in areas where or when bearded seals may be present in high concentrations, such as spring lead systems or polynya systems at Hanna Shoal (as defined by NMFS (2013) or by the MMC (2013), as described in Smith, 2011), would have greater potential to result in effects to one or more individuals, than if activities occurred in areas with low densities of bearded seals; however, the levels of effects to bearded seals from activities in areas of higher seal densities would be negligible with implementation of the mitigations required in the NMFS Biological Opinion (2013b).

Bearded seals spend their summers feeding on benthic organisms on the continental shelf in the Chukchi Sea. During winter and spring they mostly utilize leads and polynya systems where they can access patches of open water to feed and pack ice to rest. Bearded seals have been consistently documented in the Leased Area throughout the year and are usually the second most common marine mammal present, after ringed seals. During fall, a large proportion of the Beringian DPS of bearded seals migrates south into the Bering Sea with the formation of sea ice in the Bering Sea.

In the Scenario, seismic noise would occur in the initial years, giving way to the noise from highly localized ancillary activities such as sonar, coring, echosounders, etc. Marine seismic surveys could affect many bearded seals in the Leased Area; however, the most common response of bearded seals to ongoing seismic activities has been swimming and looking behavior from within a few hundred meters until the seismic vessel and airguns depart the area (Harris, Miller, and Richardson, 2001; Miller and Davis, 2002; Blees, Martin, and Ireland, 2010; Reiser et al., 2010). Existing observations indicate a possible minor avoidance reaction by bearded seals from the firing of airgun arrays, but not to an excessive degree. Consequently, bearded seals could briefly divert around active seismic surveys before resuming travel. Five marine seismic surveys are to be expected in Years 1, 8, 15, 19, and 25, under the Scenario, along with 13 Geohazard and 13 Geotechnical Surveys during Years 1-23. The small scale of the Geohazard and Geotechnical surveys, the equipment used, and the few marine seismic surveys would not interact to produce anything beyond temporary, brief avoidance behavior by bearded seals.

In Year 3 of the Scenario, exploration wells would be drilled into the formation, introducing drilling noise into the environment. Exploratory drilling would occur over a 7-year period, and during the open-water period when drilling units could be brought to the drill site. Such operations could affect bearded seals since broadband source levels from the Shell drillship *Discoverer* ranged from 177 to 185 dB re 1 μPa rms during Chukchi Sea drilling activities in 2012 (Shell, 2011a), and jack-up rigs are assumed to produce lower noise levels than drillships. Koski and Johnson (1987) concluded the area of effects for exploratory drilling noise would radiate approximately 12.4+ mi (20+ km) from an operating drillship. The limited number of exploration wells, 4 per year in Years 3-9 and 20-22, would affect some bearded seals; however, seals near the Northstar Production facility in the Beaufort Sea seem to have habituated to the activity and construction, with slightly higher numbers detected around the Northstar Production facility than in waters further from the production facility.

The effects of OCS drilling on ice seals in the Beaufort Sea have been investigated in the past (Frost and Lowry, 1988; Moulton et al., 2003). Frost and Lowry (1988) concluded that local seal populations were less dense within a 2 nmi (2.3 mi or 3.7 km) buffer of man-made islands and offshore wells that were being constructed in 1985-1987, and Moulton et al. (2003) found seal densities on the same locations to be higher in Years 2000 and 2001 after a habituation period. Thus ringed seals were briefly disturbed by drilling activities, until the drilling and post-construction activity was concluded, then they adjusted to the increased noise and activity levels for the remainder of the project.

In Year 6, subsea pipeline installation would commence, between a location near Wainwright or Barrow, Alaska, and the site of the first production platform. Forty miles of pipeline would be laid annually over a 4-year period and upon completion, work would begin on the installation of the first production platform in Year 10. Platform installation should take approximately a year to complete, followed by multiple years of well drilling. Because drilling from production platforms produces much less noise than drilling from drillships, noise effects on seals would be reduced and restricted to the immediate vicinity of the platform. Between Years 10 and 30, approximately 5 platforms would be installed in the Anchor field, approximately 5 miles (8 km) apart, with a 20 mi (32 km) distance from the Anchor field to the Satellite field where 3 more platforms would be built using similar 5 mi (8 km) spacing.

The loudest noise associated with production platform installation would be pile-driving, and Greene (1995) described pile-driving noise levels of 131-135 dB re 1 μPa (40 – 100 Hz) at 1 km (0.62 mi) from the source. Due to ice characteristics in the Chukchi Sea, production platforms in the Chukchi Sea may require larger, or more, pilings to anchor each platform to the sea floor. In either situation pile-driving sound propagation characteristics could change. The audibility range for phocid seals occurs in a 50 Hz – 80 kHz band (Ciminello et al., 2012), overlapping the 100 Hz - 2 kHz frequency noise range produced by pile driving. Since pile driving noise source levels from Cook Inlet, Alaska (Blackwell, 2005) were 190 dB re 1 μPa, and rapidly attenuated to 115-133 dB re 1 μPa within one km (0.62 mi), it is assumed similar attenuation of pile driving noise would occur in the Leased Area. Though there is overlap in the noise frequencies affected by pile-driving and the noise frequencies used by bearded seals, the overlap occurs at the bottom of the audibility spectrum for seals. Furthermore, it is generally assumed that seals would refrain from approaching noises loud enough to produce a PTS or TTS since mammals instinctively avoid injury under most situations. Pile driving could occur during the open-water season when most bearded seals are feeding, and some seals would pass through, or may remain in the Leased Area. With audible noise levels slightly above those of ambient noise within a 1 km (0.62 mi) of pile-driving activity, the effects of pile driving should include behavioral responses such as slight avoidance, and nothing more. No PTS, TTS, or other physiological responses should occur because of pile-driving or other construction activities, dredging, or pipeline construction.

The end result of the Scenario field development methodology would be 8 production platforms installed in the satellite and anchor fields. The Molikpaq is a mobile Arctic drilling platform, similar in many ways to what would be expected for production platforms in the Leased Area. Thomson and Johnson (1996) documented decibel levels of 112 dB at 1.4 km (0.9 mi) from the Molikpaq, with most of the energy occurring below 20 Hz. Assuming the decibel and frequency levels between the Chukchi Sea and Sea of Okhotsk would be similar, and since 112 dB is approximately at or below ambient noise levels for the Chukchi Sea, the radii for effects should extend to 1.4 km (0.9 mi) or less from each production platform. Not all platforms would be drilling simultaneously, however, the noise production from drilling 32 wells from 8 platforms would average 4 wells per platform in Year 25 during the peak of drilling activity. The noise footprint from this level of drilling would equate to a 1.4 km (0.9 mi) zone surrounding each production platform where manmade noise might exceed the ambient noise levels for the ocean, mostly at 20 Hz, which is within the very bottom range of the auditory bandwidth for bearded seals (50 Hz – 80 kHz). The frequencies involved with drilling lie mostly below the auditory range for seals, and any impacts from drilling noise should be minimal. Once drilling is completed, bearded seals should eventually habituate to the presence of production wells and such platforms might be expected to serve as reef habitat for some benthic and pelagic organisms as has been noted elsewhere (Todd et al., 2009).

Subsea wells would be drilled by MODUs, and the effects of such activity would be similar to the effects of drilling exploration wells. Such activity would occur between Years 12 – 23, with a maximum of 9 wells drilled in a single season. Throughout the 77 years of the Scenario, aircraft traffic, vessel traffic, and some icebreaking/ice-management would continue. Aircraft would be the likeliest means of conducting crew changeovers, with 1-3 daily flights to each production platform during the production phase. Aircraft are not used with a great deal of regularity during seismic surveys, although the capability exists and they have been used historically to support seismic operations in the Chukchi Sea on a case-by-case basis. Assuming minimum altitude requirements of 1,000 to 1,500 ft (305-457 m) ASL/AGL are applied in the Scenario, the effects of aircraft on bearded seals should be minimal. Vessel traffic during the production phase would amount to 1-2 weekly trips between the coast and each platform during the open-water season, which could affect bearded seals if seals are injured by bow thrusters or ducted propeller systems as has occurred in other high-latitude regions (Thompson et al., 2010). The applicable mitigations from NMFS (2013b) should prevent such accidents from occurring if incorporated into the Scenario.

Spills and Bearded Seals. The effects of hydrocarbon exposure on bearded seals are analyzed in the 2007 FEIS and 2011 SEIS, and in the Biological Opinion (NMFS, 2013b) and the physiological effects of oil spills on them remain consistent with what was described in those documents. For more detailed information relating to the effects of hydrocarbons on bearded seals refer to the 2007 FEIS (Section IV.C.1.h(4), pages IV 156-162), and the 2013 NMFS Biological Opinion (Sections 2.4.2.4.5., and 2.4.5.4.5).

Small spills could occur at any time during the Scenario, and would likely result from refueling accidents at sea. Small spills should have no effect on bearded seals because of the small spill size, the relatively small area contacted with oil, and the wide distribution of most bearded seals during the open-water season when vessels would be in use.

In the event of a large crude oil or condensate spill, or a gas release, some bearded seals could be affected. Due to sea floor topography, bearded seals forage widely across much of the Chukchi Sea and so should not be concentrated in any one area during the open-water season. Immersion studies by Geraci and Smith (1976b) resulted in 100% mortality in captive ringed seals. Unlike the animals in the immersion study, seals in the open water would have ice as a resting/escape platform as well as water depth and distance for escape routes from an oil spill, which they can detect and avoid (St. Aubin, 1990).

Collectively, the Scenario would mostly have short-term, minor impacts on bearded seals; however, Table A.2-73 indicates Chukchi Sea Lead System 4 (ERA 48), Herald Shoal Polynya 2 (ERA 62), and Hanna Shoal (ERA 6) were the only lead system or polynyas found to have ≥5% chance of a large spill occurring and contacting within 30 and 360 days. Large spills contacting lead systems or polynya systems could result in a large number of bearded seal mortalities, particularly if young seal pups are present (St. Aubin, 1990). Such an occurrence would produce minor to moderate effects among bearded seals trapped in an oiled lead system, though they could haul out on ice, and only patches of the lead system would be oiled. Large winter spills contacting leads and polynyas would also require time to travel from the LA or PL to a lead or polynya, weathering and dispersing along the way, which would lower the actual volume of oil or condensate to contact the ERA. With the passage of time, much of the oil could gel or emulsify in low temperatures, making spill patches easier to observe and avoid by bearded seals if gelled, or it could become frozen in ice if emulsified. Assuming a large crude oil spill occurred during winter and in a nearshore pipeline passing under Chukchi Sea Lead System 4 (ERA 48), the effects on bearded seals would be moderate with some mortalities, but no population-level effects; and less severe than a large spill contacting a polynya at Hanna Shoal (ERA 6) or Herald Shoal (ERA 62). Lead systems in the Chukchi Sea are large and should have many large areas where bearded seals could relocate to in the event of a large spill, unlike polynya systems which are isolated and lack similar areas where spills could be avoided. Though the effects of a large spill would likely be greater in a polynya than a lead system, the level of effects should remain moderate since there shouldn't be enough bearded seals in any polynya system to permit population-level effects to occur.

Spill response and cleanup activities of large spills during the open-water season should be prompt and effective, so these spills could be much more easily be addressed and unlikely to produce anything greater than negligible effects on bearded seals. Spill response and cleanup in lead systems and polynyas during winter and spring could be problematic with no way to deliver vessels to the leads in winter and the logistical obstacles.

Impacts. Most IPFs in the Scenario should have negligible overall impacts on bearded seals if NMFS mitigations are implemented. Without mitigations the level of effects would be minor, with more noise exposure, etc. Small refined crude oil, or other spills should produce no effects on bearded seals due to the limited spill size, weathering, and rapid dispersion of such a spill. Large oil or condensate spills would have minor to moderate effects on bearded seals. Minor effects to a few bearded seals would be expected during the summer and fall before sea ice blankets the Chukchi Sea. After winter sea ice sets in, bearded seals concentrate in lead systems, shear zones, and polynya areas to access water and forage. If large spills occurred during winter and contacted lead systems or polynya systems, such as those associated with Hanna Shoal, large bearded seal mortalities could occur. For such an event to occur, a spill would most likely have to occur during winter from a pipeline since the presence of sea ice throughout most of the Leased Area would act to inhibit movement of spilled oil or condensate from most LAs to lead systems many miles away. For this reason the collective effect of the Scenario on bearded seals would range from negligible (large summer crude oil, or condensate spill, or natural gas release), to moderate (large winter crude oil or condensate spill, or natural gas release). If a successful method for spill response and cleanup becomes feasible, the effects of large crude oil or condensate winter spills should change from a moderate to minor impact on bearded seals.

Ribbon Seal

Ribbon seals may be found throughout the OCS of the Chukchi Sea during the open-water season; however, the numbers of individuals detected have consistently been low, and most sightings have occurred in the southern Chukchi Sea. They differ from bearded seals in many ways, but their auditory abilities, sensitivities, and behavior remains similar enough to bearded seals that the effects analysis for bearded seals is applicable to ribbon seals.

Impacts. The effects of the Scenario on ribbon seals would mostly be consistent with what was previously described and analyzed for bearded seals; however, ribbon seals prefer open water for most of the year and would not be in the lead systems during winter which was a crucial determining factor for the moderate impact on bearded seals. Because of their solitary nature, their absence from the Chukchi Sea during winter, and their scarcity in the Leased Area and northern Chukchi Sea during summer the overall impacts of the Scenario on ribbon seals would be negligible.

Ringed Seal (Threatened)

Ringed seals may be found throughout the OCS of the Chukchi Sea during the open-water season, and the numbers of individuals detected have consistently been high in most monitoring surveys. They differ from bearded seals in many ways, but their auditory abilities, sensitivities, and behavior remains similar enough to bearded seals that the effects analysis for bearded seals is applicable to ringed seals. Such similarities indicate the effects analysis of the Scenario on ringed seals would be consistent with those already described for bearded seals, which were negligible. The numbers of ringed seals in the Chukchi and Beaufort Seas likely number over a million animals (Kelly et al., 2010), and in the highly unlikely scenario of a large spill removing several thousand ringed seals, a large population numbering over one million individuals should quickly replenish those losses within a generation.

The effects of OCS drilling on ice seals in the Beaufort Sea have been investigated in the past (Frost and Lowry, 1988; Moulton et al., 2003). Frost and Lowry (1988) concluded that local seal populations were less dense within a 2 nmi (2.3 mi or 3.7 km) buffer of man-made islands and offshore wells that were being constructed in 1985-1987, and Moulton et al. (2003) found seal densities on the same locations to be higher in Years 2000 and 2001 after a habituation period. Thus, ringed seals were briefly disturbed by drilling activities, until the drilling and post-construction activity was concluded, then they adjusted to the increased noise and activity levels for the remainder of the project.

Like bearded seals, ringed seals prefer sea ice as molting, resting, and whelping habitat; they often migrate from the Chukchi Sea into the Beaufort Sea during winter, but leave a substantial proportion of their population behind as year-round residents of the Chukchi and Bering Seas. Unlike bearded seals, ringed seals whelp in subnivean chambers sequestered under pressure ridges, and folds in the sea ice; carve and maintain breathing holes through solid sea ice; prefer landfast sea ice while using lead systems; and generally shift foraging areas in tandem with the location of sea ice.

Spills and Ringed Seals. The effects of hydrocarbon exposure on ringed seals are analyzed in the 2007 FEIS and 2011 SEIS, and in the NMFS 2013 Biological Opinion (NMFS, 2013b) and the physiological effects of oil spills on them remain consistent with what was described in those documents. For more detailed information relating to the effects of hydrocarbons on ringed seals refer to the 2007 FEIS, (Section IV.C.1.h(4) (pages IV 156-162)) , and the NMFS 2013 Biological Opinion (Sections 2.4.2.4.4., and 2.4.5.4.4).

Small refined or crude oil spills should have a negligible effect on ringed seals at any time of the year because of the small spill sizes, the relatively small area contacted with oil, rapid dispersion rates, and the wide distribution of ringed seals through much of the year. Small spills in winter would likely occur on ice or on a platform and should not have the opportunity to enter waters in the Chukchi Sea.

Ringed seals maintain a broad distribution across the Chukchi and Beaufort seas, and large crude oil or condensate spills could only affect large numbers of ringed seals concentrated in lead or polynya systems described in the bearded seal large oil-spill analysis above. The effects would be similar to what was described for bearded seals, with one main difference. Landfast sea ice is the preferred optimal winter habitat for ringed seals; however, many ringed seals are believed to use sub-optimal pack ice winter habitat since there is not enough landfast sea ice to support ringed seal population estimates (Reeves, 2014). For this reason, large crude oil or condensate spills under pack ice could have moderate effects on ringed seals, though ringed seal population densities are likely lower per unit area on pack ice than on landfast ice. Nonetheless, mortalities are likely to occur among ringed seals wintering in pack ice if a large crude oil or condensate spill occurred during winter, though the effects would probably be less than with a similar spill event contacting a polynya or lead.

Impacts. The IPFs described above would mostly have negligible to minor short-term impacts on ringed seals; however, large crude oil or condensate winter spills contacting ringed seals in polynyas, leads, or in pack ice would have moderate effects with mortalities of some seals. Widespread mortalities are not envisioned for large winter oil or condensate spills considering the assumed spill sizes, and any population losses should be recouped within one year. Gas winter releases could affect ringed seals in pack ice in a manner consistent with what has been described for large winter oil spills, because the presence of pack ice would inhibit the rapid dispersal and volatilization of dry gas by trapping it under ice. The effects of a gas release on ringed seals in pack ice would be moderate, and include mortalities for some ringed seals. The implementation of spill responses and cleanup should reduce the impacts from large crude oil or condensate spills from moderate to negligible for summer spills. If a successful method for winter spill response and cleanup becomes feasible, the effects of large crude oil or condensate winter spills should change from a moderate to minor impact on ringed seals.

Spotted Seal

Spotted seals may be found throughout the OCS of the Chukchi Sea during the open-water season; however, they have a strong tendency to remain in coastal waters, aggregating in locations like Kasegaluk Lagoon, Alaska. Other coastal haulouts occur in Peard Bay, Kogru Bay, and sites along the Chukotkan coastline. Though they differ from bearded seals in many ways, their auditory abilities, sensitivities, and behavior remains similar enough to bearded seals that the effects analysis for bearded seals is applicable to spotted seals. Such similarities indicate the IPFs from the Scenario should mostly have negligible effects on spotted seals.

Spills and Spotted Seals. The high numbers of spotted seals aggregated at Kasegaluk Lagoon and possibly other areas could make seals in those areas particularly susceptible to the effects of a large oil spill; however, a rapid response time for oil-spill-cleanup actions could mitigate those effects to a large degree. Without mitigations, the effects of a large spill on seals in Kasegaluk Lagoon would affect several thousand seals; however, recovery from such losses should eventually occur within a generation or two since it is assumed most effects would be non-lethal. Consequently, the potential impacts from large spills on spotted seals would be long-lasting, widespread, and less than severe (i.e., moderate) precluding population-level effects from of any of the IPFs.

The effects of the Scenario on spotted seals would mostly be consistent with what was previously described and analyzed for bearded seals. Spotted seals prefer nearshore open water for most of the year, and migrate into the Bering Sea to winter over which makes it unlikely any would be affected by large spills that contacted polynya or spring lead systems. Spotted seals aggregate in coastal haulouts such as SUA-Shishmaref, North (ERA 5), Kasegaluk Lagoon (ERA 1), Peard Bay Area/Franklin Spit Area (ERA 64), Smith Bay (ERA 65), Harrison Bay/Colville Delta (ERA 69), Kotzebue Sound (ERA 104), Kolyuchin Bay (GLS 135), and a LAs 30-37 on the coast of Chukotka, plus a few other locations on the Chukchi and Beaufort Sea coasts.

Seals hauled out in Kasegaluk Lagoon and around Peard Bay would be the groups most likely affected by a large spill due to their aggregation size, and chances of being contacted by a large oil spill. Large crude oil or condensate spills from nearshore PL segments would have the greatest effect on spotted seals due to their close proximity to coastal haulouts and marine habitat areas that see high levels of use. If a large crude oil or condensate spill occurred from nearshore pipeline segments, the spill might not have sufficient time to weather or disperse, and larger proportions of such spills could contact spotted seals and their habitat. If such an incident occurred, spotted seals at the contacted areas could experience mortalities. St. Aubin (1990) indicated seals likely have the ability to detect and avoid spilled oil and further stated seal pups were the demographic groups most likely to succumb to the effects of oil spills. This information indicates that if a large spill were to contact Chukchi Sea coastal haulouts where spotted seals aggregate, a large number of seal pups could die, with fewer adults experiencing the same fate. Such losses to the population should be recovered within a year or two since the adult breeding population would survive to reproduce in subsequent years. Thus, moderate impacts to spotted seals could occur if large crude oil or condensate spills contacted spotted seal ERAs in the Chukchi Sea during summer. Spills that occurred during winter would have negligible effects on spotted seals.

Condensate releases should have negligible effects on spotted seals since dry gas rapidly disperses into the atmosphere, making it unlikely spotted seals would come into contact with it.

Impacts. The high level of activity associated with the Scenario, small spills, gas releases, and large winter crude oil or condensate spills would have negligible effects on spotted seals. Large crude oil or condensate spills contacting spotted seal coastal haulouts during summer would have a moderate impact on spotted seals if haulout areas become contaminated with large quantities of oil or condensate because impacts would be long-lasting, widespread, but less than severe. The implementation of spill responses and cleanup should reduce the impacts from large crude oil or condensate spills from moderate to negligible.

Pacific Walrus (Candidate species)

In the Scenario, marine seismic noise would occur in the initial years, giving way to the noise from highly localized ancillary activities such as sonar, coring, echosounders, etc. Five marine seismic surveys are to be expected in Years 1, 8, 15, 19, and 25 under the Scenario, along with 13 Geohazard and 13 Geotechnical Surveys during Years 1-23. These activities would take place largely in open water on the Leased Area. Some walrus may encounter vessels as they move between foraging areas and ice or shore-based haulouts. Impacts are likely to be limited to temporary displacement or disturbance and are not likely to have effects on fitness or productivity.

In Year 3 of the Scenario, exploration wells would be drilled into the formation, introducing drilling noise into the environment. Exploratory drilling would occur over a 7-year period, during the open-water period when MODUs could be brought to the drilling site. Walrus would likely be displaced from drilling sites by noise and activity. The number of exploration wells, 4 per year in Years 3-9 and 20-22, would result in some loss of foraging habitat due to bottom disturbance from mudline cellers, anchoring, and deposition of cuttings. Each site that was not further developed would likely take 3-8 years to become available as foraging habitat for walrus.

Brueggeman et al (1990, 1991) monitored the behavior of walrus in response to vessels associated with exploration drilling near prospects in 1989 and 1990. They reported that none of the observed groups of walrus exhibited avoidance behavior in response to anchored or drifting vessels. Responses of walrus to moving vessels varied with distance, ranging from no response to approaching the vessel to avoidance behavior. Most walrus reacted when the vessel came within about 550 yd (500 m) of them. Impacts of vessel traffic on any of these marine mammals would be minor and short term, consisting only of temporary displacement. Seals and walrus may leave the ice, make hasty dives, or move off. Brueggeman et al. (1991) noted that the behavioral effect on walrus was of a very brief duration, with displaced walrus occasionally re-occupying ice floes as soon as the vessel passed.

Walrus commonly react to sounds from moving vessels, but most do not react to sound energy from drilling (Richardson, 1995a). While monitoring marine mammals during exploration drilling in the Chukchi Sea in 1989-1991, Brueggeman et al. (1990) noted that walrus near moving icebreakers exhibited some avoidance behavior. Most reactions of walrus to moving vessels occurred when the vessels approached to within 0.3 mi (0.5 km) of the walrus. During icebreaking activities, walrus moved 12.4 to 15.5 mi (20 to 25 km) from the operations where sound energy levels were 11%-19% above ambient sound level. Thus, walrus were simply displaced away from vessels to areas where sound levels approached ambient levels temporarily.

Walrus did not exhibit an avoidance reaction when vessels were anchored or drifting and did not appear to be affected by drilling sounds. Many walrus moved through the prospect areas during the previous drilling operations with the pack ice, and low numbers of walrus summered within the prospect area. With the retreat of the pack ice, walrus inhabited the drilling areas for only a short period of time. Walrus density, mean group size, association with ice cover, distance from the ice edge, and distance from the prospect were compared before and after drilling to evaluate responses of walrus to the drilling operations (Brueggeman et al., 1990). Walrus density and group size did not differ before and during drilling but distribution did change. Walrus showed no preference for a particular amount of ice cover before operations but preferred areas of moderate ice cover during operations, particularly operations involving icebreaking activities. The walrus were fairly evenly distributed across the pack ice and from the ice edge and prospect before operations, but they became more distant and clumped during icebreaking operations. Once icebreaking activities stopped, walrus once again became more evenly distributed, indicating that any effects were brief and that walrus may adjust to drilling, ice-management, and other operational sounds.

The probability of encountering walrus during drilling or ice management operations is highly dependent on the presence of ice in the area. The presence or absence of pack ice in the proposed drilling area during the operational period cannot be predicted at this time. During historic exploration drilling in the Chukchi Sea, ice was present in some years and not in others, with many more walrus being found in the prospect area when ice was near. If pack ice is located within 10-20 mi (16-32 km) of the drilling unit, walrus would likely be affected. Effects would probably be limited to slight changes in distribution with some walrus avoiding the area or retreating to the center of the ice floe. All such effects would be minor and temporary, lasting only as long as the ice and walrus, which move with wind and current, are in the area.

In Year 6, subsea oil pipeline construction would commence, between a location near Wainwright or Barrow, Alaska, and the site of the first production platform. Forty miles of pipeline would be laid annually over a 4-year period, and upon completion, work would begin on the construction of the first production platform in Year 10. Platform construction should take approximately a year to complete, followed by multiple years of well drilling. Because drilling from production platforms produces much less noise than drilling from MODUs, noise effects would be reduced and restricted to the immediate vicinity of the platform. Between Years 10 and 30 approximately 8 platforms would be constructed in the anchor field, approximately 5 miles apart, with a 20 mi (32 km) distance from the Anchor field to the Satellite field where 3 more platforms would be built using similar 5 mi (8 km) spacing. This would result in additional loss of benthic habitat over a period of 3-8 years for each area disturbed. Walrus may avoid areas of activity, or move through the platform fields between foraging and resting habitats.

The loudest noise associated with production platform construction would be pile-driving, and Greene and Moore (1995) described pile-driving noise levels of 131-135 dB re 1 µPa (40 – 100 Hz) at 1 km (0.62 mi) from the source. Due to ice characteristics in the Chukchi Sea, production platforms in the Chukchi Sea may require larger, or more, pilings to anchor each platform to the sea floor. Walrus may be displaced due to noise and activity associated with pile-driving or other construction activities, dredging, or pipeline construction.

The end result of the Scenario field development methodology would be a total of 8 production platforms occurring within a circular area 10 miles in diameter in the Satellite and Anchor fields. Not all platforms would be drilling simultaneously; however, the noise production from drilling 32 wells from 8 platforms would average 4 wells per platform in Year 25 during the peak of drilling activity. Walrus may be displaced due to noise and activity, and some foraging habitat may become unavailable to them for the duration of the productivity of the field.

Drilling subsea wells would likely be conducted using drilling units, and the effects of such activity would be similar to the effects of drilling exploration wells. Such activity would occur between Years 12 – 23 and would result in a maximum of 9 wells drilled in a single season. Throughout the 77 years of the Scenario, aircraft traffic, vessel traffic, and some icebreaking/ice-management would continue. Aircraft would be the likeliest means of conducting crew changeovers with 1-3 daily flights to each production platform during the production phase. Vessel traffic during the production phase would amount to 1-2 weekly trips between the coast and each platform during the open-water season. Assuming a shorebase near Wainwright or Barrow, vessel trips would pass through the route used seasonally by walrus moving between haulouts near Point Lay and the HSWUA, which could result in some disturbance as walrus dive or swim further to avoid vessels. Icebreaking and ice management activities have the potential to decrease the size of floes and the amount of preferred seasonal habitat available to walrus in the vicinity of the oil fields.

The discharge of drill cuttings, drilling fluids, and well cellar sediment that is calculated to be discharged into the water during various drilling activities (see Table 4-7) could impact the availability of benthic prey for walrus, especially if the wells are located in prime walrus foraging areas. Limitations on the volumes of discharges could reduce impacts on benthic habitat.

The level of impact to walrus would depend upon the location of the exploration wells in relation to preferred foraging habitats and the amount of other foraging habitat available to walrus. Impacts to walrus could be negligible to moderate depending on factors such as sea ice availability, vessel activity and transit routes, aircraft transit routes, and industry avoidance of walrus habitat and transit routes, such as between Hanna Shoal and the shore. At the highest level of activity in the Scenario and without appropriate mitigation, population level impacts to walrus could occur. Mitigation measures typically in place through MMPA authorizations are described in Appendix C and include the use of PSOs on vessels to identify and avoid groups of walrus, specific transit routes for vessels and aircraft designed to avoid haulouts and walrus groups, and other restrictions on industry activities which would otherwise overlap in time and space with walrus groups. For instance, in a 2013 Letter of Authorization (LOA) for the incidental take of walrus during activities associated with certain on-lease activities, USFWS required specific altitude and distance buffers to be kept for walruses in a variety of habitats (water, land, ice) for a variety of vehicles (fixed-winged aircraft, rotary-winged aircraft, boats) taking into account walrus group size (> 12 is defined as a biologically important group). Additionally, the Service outlined specific acoustic exclusion and disturbance zones during seismic surveys that also took into account walrus group size. Another condition of the LOA restricts operating below 1,500 feet ASL over the HSWUA between July 1 and September 30. Assuming the implementation of these types of mitigation measures within future take authorizations, impacts to walrus at the highest level of development in the Scenario would be moderate.

Based on previous estimates concerning operations on the Burger prospect, each platform would result in the disturbance of approximately 1,000 ft^2 (93 m^2) of benthic habitat, with the subsequent loss of foraging habitat for walrus. Each disturbed site would take approximately 1-5 years for benthic invertebrates to recolonize the site (see Section 4.3.4). It would take an additional 2-3 years for benthic invertebrates such as clams and other mollusks to attain an optimum size as walrus prey. Each disturbed site would likely be unavailable to walrus for foraging for approximately 3-8 years. Additional benthic habitat would be disturbed by an estimated 190-210 miles (305-338 km) of offshore oil and gas pipelines. This loss of foraging habitat over a period of approximately 25 years could potentially result in population level effects to walrus unless project-specific mitigation measures are applied. The USFWS has identified the HSWUA as preferred foraging habitat for walrus through tagging studies (Jay, Fischbach, and Kochnev, 2012), and tagging studies indicate that walrus habitually move through and forage in the adjacent Leased Area. The NMFS and MMC have identified different iterations of Hanna Shoal that largely overlap with each other, and generally lie within the HSWUA, as important foraging habitat for walrus (Smith, 2011 in MMC, 2013; NMFS, 2013b).

Additional protective mitigation measures could be put in place which would lessen the potential impacts to walrus. For example, if aircraft operators are required to fly a minimum of 1,500 ft (457 m) /ASL/AGL and avoid groups of walrus hauled out onshore or on ice, as is typically required by MMPA authorizations issued by the USFWS, the effects of aircraft on walrus would be limited to occasional short term disturbance. Limiting oil and gas activities within walrus habitats such as the HSWUA to time periods that do not overlap with the presence of walrus would lessen impacts to walrus, but would not mitigate impacts to prey species and foraging habitat. This would require monitoring of the area for walrus presence. Prior to authorizing the take of marine mammals such as walrus, USFWS will require whatever additional mitigation measures it deems necessary to meet the substantive MMPA standards of small numbers of take, negligible impacts to the species or stock, and no unmitigable adverse effects on the availability of the species for subsistence uses. Consistent with this concept, USFWS's current Incidental Take Regulations for 2013-2018 for oil and gas activities in the Chukchi Sea contains a provision explaining that heightened review and restrictions – i.e. seasonal restrictions, reduced vessel traffic, rerouting of vessels, and/or minimum flight altitudes – may apply to activities proposed to occur within the HSWUA when walrus are present. Any oil and gas activities which would cause the take of walrus in HSWUA or elsewhere, and which cannot be sufficiently mitigated to meet the substantive regulatory criteria mentioned above, will not be eligible for a take authorization and would not be approved by BOEM. In this manner, the MMPA and the take authorization process serves as a ceiling on the level of direct impacts expected to occur to walrus.

Any ground disturbing activities taking place within walrus habitats such as the HSWUA would still result in the temporary loss of available foraging habitat due to the loss of benthic invertebrate prey. During the exploration phase, this could occur from exploratory drilling, anchoring, excavating well cellars, placing blowout preventers or other bottom-disturbing activities. During the production phase, bottom disturbance could occur from drilling, placing templates, dredging for pipelines, anchoring, excavating well cellars, placing blow out protectors, or other activities. Some disturbed seabed areas would be re-colonized relatively quickly. For example, once pipelines were placed and reburied, fauna would begin to return to the sea floor area within a few years. In the case of platforms and other production infrastructure, most of the disturbed habitat would eventually be re-colonized by benthic invertebrates after the infrastructure had been removed from the sea floor. This would occur gradually through the later periods of the proposed Scenario.

The biggest potential impact to walrus from this Scenario is disruption to their seasonal migration and distribution in the Chukchi Sea (pers. comm J. Garlich-Miller, USFWS). The potential for such impacts may be reduced via mitigation measures specifically tailored to these movement patterns. For example, there are no walrus in the Chukchi Sea from December through April (Garlich-Miller et al., 2011; Jay, Fischbach, and Kochnev, 2012), and thus activity in the Leased Area during this time would not impact walrus movement and distribution. From late April to early May, walrus move into the Chukchi Sea and tend to concentrate in nearshore habitat and on land (Garlich-Miller et al., 2011; Jay, Fischbach, and Kochnev, 2012), so minimizing activities in nearshore areas would help minimize impacts to walrus during Spring. Walrus tend to move to offshore areas from June to August, depending on ice coverage (Garlich-Miller et al., 2011; Jay, Fischbach, and Kochnev, 2012), meaning onshore activities pose little risk of impacting walrus during that time, but offshore operations may pose more of a risk. In September, walrus change their distribution and once again move inshore and to traditional haulout locations prior to migrating out of the Chukchi Sea in December forage (Garlich-Miller et al., 2011; Jay, Fischbach, and Kochnev, 2012), meaning offshore oil and gas activities pose little risk of impacting walrus at that time.

The effects of climate change, including decreasing sea ice, earlier break-up and later freeze-up, are expected to increase if current trends and predictions are correct, and could alter the timing of walrus' arrival and departure from the Chukchi Sea, as well as habitat use by the species as walruses are expected to become increasingly reliant on terrestrial haulouts as their traditional sea ice foraging platform becomes less available. These potential changes in temporal and spatial distribution are likely to affect the extent to which walruses may be affected by Scenario activities as the life of the Scenario progresses. What changes in probability and magnitude of impacts is difficult to predict. Walruses are arriving in the Chukchi Sea earlier in the year and departing later in the year than has been documented in previous decades (Jay, Fischbach, and Kochnev, 2012). If this trend continues, walruses could be present in the vicinity of oil and gas activities in the Leased Area for a greater portion of the year, increasing the period of potential disturbance to individuals. If walruses continue to rely on HSWUA in the future, they will experience increased energetic costs as a result of longer transit times between foraging areas and areas suitable for hauling out. These costs could exaterbate stress responses to anthropogentic anctivities such as noise and vessel presence. Althernately, walruses could begin to rely more heavily on benthic environments in the immediate vicinity of terrestrial haulouts. This could reduce the number of individuals transiting to HSWUA and potentially being exposed to Scenario activities occurring on leases as well as any traffic between the leased area and the coastal shorebase(s). However, increased reliance of foraging grounds immediately adjacent to haulouts could lead to localized prey depletion and increased competition for food resources, which could adversely affect the health and body condition of individual walruses, and could have population-level effects. Sufficient information to confidently predict changes in spatial and temporal distribution of walruses in the Leased Area in later years of the Scenario does not exist.

Industry activities taking place during this time period may require additional mitigation measures or may not be authorized under the Chukchi Sea ITRs, if large concentrations of walrus are within the HSWUA at the time certain Scenario activities are proposed.

Spills and Walrus. Oil spills or condensate spills from loss of well control could occur during the development and production phases. Fuel spills could occur at any time during the Scenario, and would most likely result from refueling accidents at sea. Small spills having volumes up to 50 bbl would affect a relatively small area within the Leased Area and would disperse quickly. Walrus would likely avoid the area associated with cleanup activities and few walrus are likely to be impacted by small spills.

Large spills up to 5,100 bbl could impact walrus, particularly if they contacted marginal sea ice habitat, important foraging habitat such as that identified by the NMFS or MMC-defined Hanna Shoal areas and HSWUA delineations, or the shore near walrus haulouts. Impacts could include disturbance and displacement; inhalation of contaminants; eye, mouth or mucous membrane injuries; or ingestion of contaminated prey. If sea ice retreat trends continue and walruses increasingly rely on terrestrial haulouts, the effects of large spills contacting haulouts in later years of the Scenario may be magnified, as greater numbers of walruses could be present at the contacted haulout site(s) and experience the adverse impacts described above. Cleanup activities may haze walrus away from contaminated sites, but ingestion of contaminated prey over time would be difficult to mitigate. Adherence to the USFWS's Pacific Walrus Response Plan in the event of a large spill could reduce the potential for these adverse impacts.

Impacts. The high level of activity predicated in the Scenario, combined with the proximity to important summer foraging habitat for walrus, such as the NMFS or MMC-defined Hanna Shoal areas/or the HSWUA, and shore-based infrastructure being located near important terrestrial resting habitat, could lead to long-lasting, widespread, and less than severe (i.e., moderate) impacts to walrus. Scenario activities occurring in areas where walrus may be present in high concentrations, such as HSWUA or a large portion of Hanna Shoal (as defined by the NMFS or by the MMC), would have greater potential to result in effects to one or more individuals than if activities occurred in areas with low densities of walrus. For example, activities on leases that occur within the HSWUA or within the portion of NMFS's or the MMC's defined Hanna Shoal boundary area that overlaps with the HSWUA have a greater likelihood of impacting walruses than activities occurring on leases outside of the HSWUA (including the leases north of latitude 72°N, which are within both the NMFS and MMC-delineated boundaries of Hanna Shoal) because of closer proximity to high seasonal concentrations of walrus (Jay, Fischbach, and Kochnev, 2012). The overall potential population-level impacts to walrus if Scenario activities occured in Hanna Shoal would not differ in scale (see Section 4.2) from those if Scenario activities occurred in the HSWUA because of the proximity to and overlap of the two areas.

Polar Bear (Threatened)

Polar bears from the Bering/Chukchi Sea population and from the Southern Beaufort Sea population overlap in the northeastern Chukchi Sea. Polar bears spend most of the year on sea ice. As long as sea ice remains in the area, polar bears will remain with the ice. When the sea ice retreats northward of the continental shelf, some bears remain with the sea ice while others swim ashore and spend the ice free season on barrier islands and along the coast.

In the Scenario, seismic noise would occur in the initial years, giving way to the noise from highly localized ancillary activities such as sonar, coring, echosounders, etc. Five marine seismic surveys are to be expected in Years 1, 8, 15, 19, and 25 under the Scenario, along with 13 Geohazard and 13 Geotechnical Surveys during Years 1-23. These activities would take place largely in open water in the Leased Area. A few polar bears may encounter vessels as they move between sea ice and shore. Impacts are likely to be limited to temporary displacement or disturbance and are not likely to have effects on fitness or productivity.

In Year 3 of the Scenario, exploration wells would be drilled into the formation, introducing drilling noise into the environment. Exploratory drilling would occur over a 7-year period, and during the open-water period when MODUs could be brought to the drilling site. Polar bears are unlikely to occur in the Leased Area during the open-water season.

In Year 6, subsea oil pipeline construction would commence, between a location near Wainwright or Barrow, Alaska, and the site of the first production platform. Forty miles of pipeline would be laid annually over a 4-year period and upon completion work would begin on the construction of the first production platform in Year 10. Platform construction should take approximately a year to complete, followed by multiple years of well drilling. Because drilling from production platforms produces much less noise than drilling from MODUs, noise effects would be reduced and restricted to the immediate vicinity of the platform. Between Years 10 and 30 approximately 8 platforms would be constructed in the anchor field, approximately 5 miles apart, with a 20 mi (32 km) distance from the Anchor field to the Satellite field where 3 more platforms would be built using similar 5 mi (8 km) spacing. Some polar bears may avoid areas of activity, or move through the platform fields between foraging and resting habitats. Females with cubs are typically the most sensitive to disturbance; however, polar bears commonly move through the oil fields of the North Slope and industry activities do not seem to cause impacts to fitness or productivity.

The end result of the Scenario field development methodology would be 3-5 production platforms occurring within a circular area 10 miles in diameter in the satellite and anchor fields. Not all platforms would be drilling simultaneously; however, the noise production from drilling 32 wells from 8 platforms would average 4 wells per platform in Year 25 during the peak of drilling activity. Polar bears may be temporarily displaced due to noise and activity associated with pile-driving or other construction activities, dredging, or pipeline construction, or they may approach activities. Activities taking place in the Leased Area during the open-water season are unlikely to encounter or cause impacts to polar bears.

Drilling and ice management sound energy will have little effect on polar bears. At most, bears have demonstrated curiosity when encountering vessels and will approach them on ice or in water on occasion (Harwood et al., 2005). Although polar bears can be drawn to areas of human activity, the drilling operations would take place during the open-water season, so few encounters with polar bears are anticipated. If avoidance and interaction plans follow USFWS guidelines, encounter with polar bears is likely to be minimized.

Drilling subsea wells would be conducted with the use of MODUs, and the effects of such activity would be similar to the effects of drilling exploration wells. Such activity would occur between Years 12 – 23 and would result in a maximum of 9 wells drilled in a single season. Throughout the 77 years of the Scenario, aircraft traffic, vessel traffic, and some icebreaking/ice-management would continue. Aircraft would be the likeliest means of conducting crew changeovers with 1-3 daily flights to each production platform during the production phase. Assuming minimum altitude requirements of 1,500 ft (457 m) ASL/AGL are applied, and the avoidance of polar bears onshore or on ice, the effects of aircraft on polar bears would be limited to occasional short term disturbance. Icebreaking and ice management activities have the potential to displace polar bears and to decrease the size of floes and the amount of preferred habitat available to polar bears in the vicinity of the oil fields.

Mitigation measures typically in place through MMPA authorizations include the use of PSOs on vessels to identify and avoid polar bears onshore or on ice, specific transit routes for vessels and aircraft designed to avoid barrier islands and polar bears, and limiting industry activity in the Chukchi Sea. Assuming MMPA authorization measures are enforced, impacts to polar bears at the highest level of development in the Scenario would be negligible.

Spills and Polar Bears. Oil spills or condensate spills could occur. Fuel spills could occur at any time during the Scenario, and would most likely result from refueling accidents at sea. Small spills having volumes up to 50 bbl would affect a relatively small area within the Leased Area and would disperse quickly. Polar bears may avoid the activity associated with cleanup activities or be drawn to the activity out of curiosity. However, few polar bears are likely to be impacted by small spills.

Large spills up to 5,100 bbl could impact polar bears, particularly if they occurred in marginal sea ice habitat or onshore near barrier islands. Impacts could include disturbance and displacement; inhalation of contaminants; eye, mouth or mucous membrane injuries; or ingestion of contaminated prey. Oiled polar bears would likely ingest oil during grooming efforts and would be susceptable to hypothermia. Heavily oiled bears would not survive unless capture and cleaning efforts were successful. Polar bears that ingest contaminated prey could suffer injury or mortality due to liver and/or kidney damage. Cleanup activities may haze polar bears away from contaminated sites, but ingestion of contaminated prey over time would be difficult to mitigate.

Impacts. Much of the high level of activity during the Exploration and Development phase predicated in the Scenario is focused during the open-water season when polar bears are not likely to be present. Polar bears are more likely to be present during the winter season and during the production phase. Because polar bears commonly move through oil industry areas on the North Slope and in the Beaufort Sea with only negligible impacts, it is likely that routine oil and gas activity in the Leased Area would cause negligible impacts. Impacts to polar bears from a large spill would be minor to major, dependent upon the location and timing of the spill.

4.3.7.2. Alternative II – No Action

Under Alternative II, Lease Sale 193 would not be affirmed and no leases would be available for further exploratory drilling or for development within the Chukchi Sea Leased Area. Exploration activities such as seismic surveys, which are not tied to leases, would continue. Impacts from vessel traffic and noise associated with various seismic surveys would continue. Impacts from exploratory drilling, pipeline route clearance, shallow hazard surveys, and activities related to on-lease exploration and production would not occur unless additional lease sales were held and leases issued at a later date. Selecting Alternative II would result in no impacts to all marine mammals.

4.3.7.3. Alternative III – Corridor I Deferral

Alternative III provides the largest deferral area of the action alternatives – a corridor approximately 60 miles (97 km) wide along the Chukchi Sea shoreline. If Alternative III were selected, the distance from the shore to many activities could be greater than under Alternatives I and IV. No exploration or development drilling or platform construction would occur within the corridor, although certain activities (i.e., installation of a pipeline extending from the leases outside the corridor to the shore) could occur there. Of the Lease Sale 193 leases, only five are within Corridor I.

The minimum distance from shore under Alternative III could be greater for the following than under the other action alternatives: length of pipeline from a platform to shore; travel distances from vessels and aircraft; source of discharges, emissions and noise from drilling and platforms; and, potentially the source of a large offshore oil spill.

The primary benefit to marine mammals of the corridor provided by Alternative III is that it would move potential sources of adverse effects farther away from important coastal habitats. The increased distance between offshore development and coastal habitats could decrease the percent chance of spilled oil contacting marine mammals that use the spring lead system (i.e., bowhead and beluga whales) and coastal habitats (i.e., walrus and spotted seals). The increased distance could also 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 onshore by a lack of sea ice in late summer and fall. The greater use of the coastline by large aggregations of walrus puts them at increased risk from oil spills and disturbance events onshore. The wider corridor under Alternative III could slightly decrease the risk of impacts from disturbance and oil spills to the species. Additional protection of the nearshore spring lead system, parts of which would be deferred by the wider coastal corridor, would be beneficial to ringed and bearded seals. Using the Impacts Scale in Section 4.2, the level of impacts under Alternative III would be consistent with Alternative I.

4.3.8. Terrestrial Mammals

4.3.8.1. Alternatives I and IV

Impact Producing Factors

The potential effects to terrestrial mammals from the Scenario come from aircraft noise; vehicle and heavy equipment noise, construction activity noise; and the physical presence of vehicle and heavy equipment, aircraft, construction activity, and camps. These disturbances were analyzed in detail in the 2007 FEIS (pages IV-172 – IV-178), 2011 SEIS (pages IV-116 – IV-119; IV-250 – IV-257), and the 2012 NPR-A FEIS (USDOI, BLM, 2012). Relevant portions of those analyses are incorporated by reference and summarized below. Additional information is also provided as appropriate.

The following analyses consider the effects of ongoing climate change, and how the IPFs of the Scenario could affect terrestrial mammals in a shifting baseline. Terrestrial mammal numbers and distributions will likely shift over time in response to changes in habitat and food stocks, throughout the life of the Scenario. Some species such as grizzly bears and furbearers could benefit from climatic changes, if the environment allows for adequate prey species. Conversely, other species such as caribou could possibly suffer adverse effects if the vegetation shifts from a lichen and tundra-dominated system to a shrub-dominated system. An earlier spring and summer could adversely affect life cycle events, and mortalities could occur from rain on snow events, earlier river breakups, increased evaporative losses from the soil, etc.

None of the IPFs addressed below should have appreciable direct interactions with climate change effects, and these effects should not appreciably increase for species that are increasing numerically or in distribution. The effects on numerically decreasing species could increase or decrease depending upon populations and shifting species ranges and habitats. See Section 5.2.7 for more detailed analyses of climate change effects on terrestrial mammal species.

Exploration

Noise

Vehicles and Construction Equipment Noise. Caribou would mostly avoid moving vehicles whenever possible unless large movements or migrations of those animals are underway.

Muskox and grizzly bear reactions to vehicle or heavy equipment operations are usually similar to those of caribou; however, muskox and grizzlies can sometimes turn aggressive if they perceive a threat, if approached too closely, or if bears associate human presence with food.

Aircraft Noise. Caribou often respond to aircraft noise with heightened alertness, nervousness, and flight responses. Under such circumstances, mothers could become separated from their young, individual animals could injure themselves, and energetic losses and other physiological changes could occur.

Muskox responses to aircraft noise are similar to those of caribou, and thus the anticipated effects of aircraft noise on muskoxen are consistent with what has been described for caribou. Muskoxen occur in smaller groups than caribou, and the number of muskox affected would be much smaller than the number of caribou that could potentially be affected. Since muskox do not move to coastal areas for insect relief, there is less likelihood of disturbing large numbers of them along the coast.

Aircraft noise sometimes startles grizzly bears that haven’t habituated to such disturbances. Studies and analyses of this phenomenon are described in the 2007 FEIS and the 2011 SEIS. In such instances, bears quickly seek out the nearest cover, and in doing so, mothers from be separated from bear cubs. Lost or abandoned cubs would face increased risk of death from other predators, starvation, exposure, or accidents.

Arctic and red foxes are not affected by aircraft noise as evidenced by their continuous presence near areas where air traffic occurs. In contrast, wolves and wolverines are often sensitive to aircraft noise, particularly helicopter noises, and can be expected to react in a manner similar to grizzly bears if approached too closely.

Accidental Oil Spills

Small Refined Spills. Small refined spills should have no effects on terrestrial mammals considering the highly localized distribution of small spills, distances from offshore activities to GLSs or LSs important to terrestrial mammals; and the presence of people and infrastructure near onshore pipelines or infrastructure which would discourage terrestrial mammals from lingering near small refined oil spills.

Development

Presence of Camps. Terrestrial mammals are inquisitive and do not typically avoid buildings or facilities unless some sort of activity occurs at the site. Caribou often use the Trans-Alaska Pipeline as shade on sunny days in areas where the pipeline is elevated, and it is reasonable to assume some terrestrial mammals would position themselves around buildings for protection from bad weather when possible. The IPF with the greatest potential to affect terrestrial mammals is the human activity associated with buildings. Effects due to human activity, to include pedestrian traffic, would be highest during construction and deconstruction activities.

Production

Accidental Oil Spills and Gas Releases

Large Spills. The effects of large oil spills are described in the 2007 FEIS, 2011 SEIS, and 2012 NPR-A FEIS. Oil slicks originating in the offshore environment should have limited effects on grizzly bears, furbearers, and muskoxen. If a large spill were to wash ashore, several hundred to a thousand caribou could come in contact with the oil, although this would only happen under a very restricted set of circumstances that are unlikely to occur. In contrast, very few muskoxen or grizzly bears could be oiled under similar conditions because of their low population densities and wide distribution. Furbearers and grizzly bears may be attracted to feed on caribou or marine mammal carcasses that occur from an oil spill.

Gas Releases. A large condensate release from a loss of well control is of little concern to terrestrial mammals because of weathering, and the distances between leased areas and the coast that would prevent contact with coastal areas.

In the event of an onshore pipeline rupture, there would be a short-term release lasting less than one day, that could extend downwind for about a half mi (0.9 km) and would quickly dissipate once the blowout or leak was stopped. Leak detection systems in a natural gas pipeline would automatically detect any leaks in the pipeline and close the pipeline isolation valves to seal off the affected section of pipeline until the leak could be repaired. Subsequent releases would almost entirely be in a vaporous form that should rise into the atmosphere. If ignition were to occur in the vicinity of released gas, large explosions would occur as the released gas combusts (Appendix A, Section A-6). Onshore gas releases would contact habitat for terrestrial mammals; however, no GLSs would be contacted based on the assumption pipelines would come ashore somewhere generally between Wainwright or Barrow, Alaska and Barrow, Alaska. Terrestrial mammal GLSs along the Chukchi Sea coast are located south of the potential landfall area and GLSs for the TLH and CAH would remain outside pipeline routes from the Chukchi Sea Coastline to TAPS.

Oil-Spill Response, Recovery and Cleanup

A direct consequence of spill response activities would be displacement of terrestrial mammals from oiled areas until the cleanup process is complete. Activities that could affect terrestrial mammals include air traffic, vessels operating in nearshore areas, and the presence of people working to remove spilled oil. Vessel and aircraft traffic associated with an oil-spill response and cleanup may startle caribou, muskoxen, grizzlies, or wolves. Activities such as in-situ burning and animal rescue could displace animals from an oiled area, lessening the potential for those animals to contact oil. It is likely some bears and other scavenging mammal species could be disturbed while feeding on carcasses, potentially creating bear-human conflicts. Cleanup activities such as beach cleaning may be performed with a high degree of success using newer technologies (Painter, 2011), particularly if substrate is silty or sandy or if there is a layer of permafrost near the substrate surface. However, other activities such as spill cleanup under ice or in areas of broken ice may be more problematic. (NRC, 2014; PAME, 2014).

Impacts of the Scenario through Time

Exploration (Years 1-5)

Aircraft

Aircraft would be used throughout the 77-year life of the Scenario. Aircraft traffic would occur in tandem with exploration activities in the offshore during Years 1-5. Disturbance of caribou associated with exploration activities would come primarily from helicopter traffic. Caribou have been shown to exhibit panic or violent flight reactions to aircraft flying at elevations of 60 m (162 ft) or less and exhibit strong escape responses (animals trotting or running from aircraft) to aircraft flying at 150-300 m (500-1,000 ft) (Calef, DeBock, and Lortie, 1976). These documented reactions of caribou were from aircraft that circled and repeatedly flew over caribou groups. Some of the aircraft traffic associated with exploration is likely to pass overhead of caribou once during any flight to or from the platforms; the disturbance reactions of caribou are expected to have no effect on caribou herd distribution and abundance.

The majority of flight paths would have aircraft flying from coastal communities to offshore operations using helicopters, with the potential for some marine mammal monitoring and marine mammal surveys using fixed-wing aircraft. Based on previous experience, there would be a limited number of flight routes over onshore coastal areas with rotary or fixed-wing aircraft that could affect terrestrial mammals. The ensuing effect of low-altitude flights on caribou in coastal areas would likely be minor (most common effect) to moderate (extreme incidents of disturbance) depending on the numbers of caribou affected and their reaction to aircraft operations. Effects to bull caribou in the vicinity of Cape Lisburne and Kasegaluk Lagoon could include escape reactions among the caribou. Beyond the energetic losses individual animals would incur, greater effects would be unlikely for adult male caribou. If female caribou with calves or parturient caribou cows are disturbed, female caribou could become separated from the calves, or pregnant caribou could abort fetuses as a byproduct of invitro stresses. Such death among caribou calves supports the analytical assumption of moderate effects.

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 acclimate 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).

Industry typically maintains altitudes >1,000 ft (305 m) above ground level (AGL). If industry were to adhere to the 1,500 ft (457 m) AGL altitude requirement for operations around marine mammals, such effects could be mitigated to negligible levels of effect. Muskox, grizzly bears, and furbearers could be affected similarly, but maintaining the 1,500 ft (457 m) AGL protective measure would ensure these species experience negligible effects from air traffic in onshore areas.

Accidental Oil Spills

Small refined oil spills could occur during the Exploration phase, in conjunction with geological and geophysical surveys or exploration drilling. Section 4.1.2.5 and Tables 4-1 and 4-2 describe the assumptions concerning small oil spills. Small refined spills could occur during the open-water season. Small spills are 50 bbl or less; Tables A.1- 24 and 25 show small spills would evaporate and disperse within three days or less during summer, and most have little (<0.5%) chance of contacting GLSs (Table A.2-37). Because small refined offshore oil spills are not estimated to contact land they should not affect terrestrial mammals.

Exploration and Development (Years 6-9)

During the development phase, there would be an increase in aircraft use along coastal areas and between communities, the coast, and offshore platforms. Flights to offshore drilling rigs and platforms would have no effect on terrestrial mammals, except the occasional furbearer in winter. Flights between communities, camps, and staging areas would affect very few terrestrial mammals except for caribou, which often occur in herds exceeding one thousand individuals, Overland flights below 1,000 to 1,500 feet could affect them, muskoxen, or grizzly bears.

Vehicle and heavy equipment noise would occur in support of pipeline construction, particularly at staging areas and within onshore pipeline right of ways. Onshore pipeline work would occur during the development period in Years 6-9 and the gas development and production period, Years 27-30, starting from an onshore location between Wainwright and Barrow, crossing overland to join the TAPS.

Pumping stations would be required for both the oil and the gas pipelines. Long-term effects to muskoxen are not expected because pipeline and road construction would occur during winter, which should not separate muskox cows from their progeny, additionally, the fact that muskoxen generally remain in place during winter should make them easy to avoid. The effects of vehicle and heavy equipment noise are consistent with what was described in the 2007 FEIS, 2011 SEIS, and 2012 NPR-A FEIS (USDOI, BLM, 2012).

Transportation around villages, camps, and staging areas would involve vehicle traffic and heavy equipment use with an accompanying increase in noise. Large mammals such as caribou, muskoxen, and grizzly bears generally avoid communities and areas with a lot of activity, so it is unlikely there would be more than a few individuals near communities, camps, and staging areas. However, local Arctic fox numbers may increase around some areas, and grizzly bears may occasionally be attracted if the potential for finding food exists.

Caribou could be disturbed by vehicle noises or noise produced by the operations of heavy equipment, although they typically avoid communities, camps, and staging areas. This avoidance would likely preclude exposure at such locations, so to exposure to pipeline corridors would be limited. Adult female caribou with calves are most likely to react to such noises, while male caribou are the least likely to react. During summer, caribou cows and calves from the WAH are the most likely to be affected by noises from vehicles and heavy equipment use because WAH caribou bulls mostly summer near Cape Lisburne. Pipeline construction would occur during winter when WAH and

CAH caribou are likely wintering south of the Brooks Range. Consequently, there should be negligible effects to WAH caribou from vehicle and heavy equipment noise.

The CAH have thrived in the midst of a large onshore oilfield with extensive pipeline construction since the Prudhoe Bay fields were first developed in the 1970s. Today, this population continues to grow while calving in the oilfields. There is no evidence indicating the construction of a pipeline would create anything other than temporary disturbances to WAH caribou. Over time, monitoring and maintenance of the pipeline would require periodic vehicle traffic and heavy equipment operation, which would reintroduce chronic vehicle and heavy equipment noise into the environment. However, the 2012 NPR-A FEIS (citing Murphy and Lawhead, 2000) found moving vehicles and foot traffic disturb caribou much more than the associated noise, though the CAH is likely more tolerant of such disturbances than the WAH and TCH.

TCH caribou are year-round residents on the Arctic Coastal Plain (ACP) in the vicinity of Teshekpuk Lake, Alaska. Any vehicle or heavy equipment noise produced near Teshekpuk Lake could have impacts to the TCH caribou. However, because of their tendency to remain in one place, there should be few effects to the TCH from vehicle or heavy equipment noise if construction does not occur near the Teshekpuk Lake Special Management Area (TLSA). If the TLSA is avoided, negligible impacts would be expected from vehicle and heavy equipment noises.

Some muskoxen in the vicinity of pipeline routes would likely be exposed to sounds from vehicles and heavy equipment operations. Unlike caribou, muskoxen are year-round residents within their home ranges, and would be exposed to vehicle noise and aircraft traffic associated with winter construction activities. Such exposure could stress small groups of muskoxen and could result in energetic losses among individual muskoxen. Muskoxen mostly fast during winter and additive energetic losses could very likely lead to decreased fitness and survival probabilities.

Muskoxen, like caribou, can be affected by vehicle and heavy equipment noise, particularly during the April-August calving and post calving season. Bull Muskoxen could become aggressive towards disturbances and perceived threats such as noisy vehicles or heavy equipment.

Grizzly bears, particularly those denning in riverbanks and gravelly areas, could be disturbed by vehicle and heavy equipment noise. If such disturbances occurred during winter, some bears could be roused from hibernation and forced from winter dens. The resulting energetic losses to those bears could be catastrophic for the bear if that individual could not find another den location and could not resume hibernation. The BLM analyzed this interaction in the 2012 NPR-A FEIS (p. 199) stating major noise sources within a few miles of grizzly dens could exclude those bears from their preferred denning sites.

Arctic foxes, and red foxes to a lesser degree, readily habituate to a wide range of anthropogenic disturbances, including vehicle and heavy equipment noises. These noise sources are not expected to injure Arctic foxes or exclude them from the vicinity of operations or a construction site.

Unlike foxes, wolves and wolverines usually avoid construction and other activities, and generally avoid human habitations.

Small numbers of caribou typically avoid approaching camps, larger herds (>20) may approach or even pass through camps if engaged in group movements for insect relief or feeding. Electrified fences surrounding enclosures are ineffective against caribou because their hollow hair insulates caribou from the electrical charges. Physical barriers such as wire or wood fencing are often effective if properly constructed. The greatest effect the presence of camps would have on caribou would be to force caribou to skirt around the camp if moving to an insect relief, feeding, or sheltering area. Such an effect would result in very little additive energetic losses to an individual animal and the ensuing impact from camp presence on caribou would be negligible.

Muskox generally avoid areas that are occupied by people, so the most likely effect of camps on muskoxen would amount to excluding muskoxen from the vicinity of the camp.

Camps usually have a beneficial effect on foxes in that they provide better denning habitat and are protected from larger predators due to the proximity to people and infrastructure.

The removal of gravel should have no effect on caribou due to the isolated locations, and the limited extent of excavation areas. Gravel slopes serve no purpose as caribou habitat so the placement of mining pits and excavation areas should not affect caribou. The IPFs of vehicle and heavy equipment noise/presence address any secondary effects of gravel mining on caribou.

Muskox could be affected by the locations of gravel mining areas if those areas occur in riparian zones used by muskoxen. The ground disturbance could remove some willow habitat for muskoxen, possibly reducing the overall habitat available to muskoxen in some locales.

Along the ACP and in the NPR-A, grizzly bears often create dens in gravelling areas that preferentially have willow or shrub groundcover whose roots maintain the integrity of the den.

Gravel mining may disturb some foxes from den sites; however, wildlife surveys would allow operators to detect dens and avoid physically disturbing such sites. The most vulnerable time for denned foxes occurs during late winter through early summer when foxes are rearing their young. Wolverines, wolves and other furbearers range widely across the ACP and Brooks Range foothills, or use different habitats that make them much less susceptible to the effects of gravel mining than foxes.

Accidental Oil Spills

Small refined spills have the potential to occur during the Exploration and Development phase of the Scenario, and in conjunction with geological and geophysical surveys, exploration drilling, and initial development activities such as facility construction and pipeline installations. Spill characteristics and effects for small refined oil spills would be consistent with those described in the Exploration phase, and should not affect terrestrial mammals.

Exploration, Development, and Production (Years 10-25)

The effects of aircraft on terrestrial mammals during the exploration, development, and production phase of the Scenario would be consistent with what was described in the exploration and development phase. Likewise, the use of vehicles and heavy equipment in onshore areas and activities would be the same as was described for the exploration and development phase.

Accidental Oil Spills

Small Spills

Small refined, condensate, and crude oil spills have the potential to occur during the Exploration, Development, and Production phase of the Scenario, and in conjunction with ongoing surveys, exploration drilling, and development activities such as platform and facility construction and pipeline installations. Spill characteristics and effects would be consistent with those described for small oil spills in the Exploration (Years 1-5), and Exploration and Development (Years 6-10) phase of the Scenario, and they should have no effects on terrestrial mammals.

Section 4.1.2.5 and Tables 4-1 and 4-2 describe the assumptions concerning small condensate or crude oil spills. Small crude oil spills normally persist for a longer period than refined oil spills, and small condensate spills persist for a shorter time period than small crude oil spills. Low-volume spills are considered likely under the Scenario. The largest number of small crude and condensate spills would likely occur during development and production. Up to 520 small crude oil or condensate spills are estimated; annually, 0–12 spills could occur, totaling up to 36 bbl (Tables 4-1 and 4-2). Crude or Condensate spills up to 3 bbl are expected to evaporate and disperse within 3 days, and spills <1 bbl should evaporate and disperse within 10 hours. More in-depth information on small oil spill characteristics is found in Section 4.1.2.5.

A small crude oil spill ranging up to 700 bbl could occur from an onshore pipeline during production years (Table 4-2). Such a spill would contact tundra vegetation, and could potentially affect terrestrial mammals. Caribou and muskoxen would be unlikely to ingest appreciable amounts of oiled vegetation since they are selective in what plants they eat (Kuropat and Bryant, 1980). Likewise, grizzly bears are highly selective on what berries or vegetation they consume, and most furbearing animals subsist on other animals. In most instances control and cleanup operations (ground traffic, air traffic, and personnel) at a spill site would frighten most terrestrial mammals away from spill-contaminated areas, limiting the potential for animal exposures to spilled crude oil. In most cases, onshore oil spills would not affect mammals directly. Small oil spills that are not successfully cleaned up could persist for a longer period of time, increasing the chance for mammalian exposure to spilled crude oil.

Large Oil Spills

Section 4.1.2.5 and Table 4-3 describe the assumptions concerning large oil spills. The potential for large spills to contact GLSs and LSs where terrestrial mammal species occur along the Chukchi and Beaufort Sea coasts are described in Appendix A. Due to updated GLSs, Leased Area, and other model refinements, BOEM has recalculated the probabilities of large oil spills contacting resource areas important to terrestrial mammals (Table A.1-17).

The following paragraphs present the results (expressed as a percent chance) estimated by the OSRA model, for values ≥5%, of a large spill contacting habitats important to terrestrial mammals. In this analysis, large oil spill contact less than 5% would likely be too small, widely dispersed and weathered to produce appreciable impacts on terrestrial mammals based on the spill assumptions in Table 4-3. More detailed information on large oil spill characteristics are outlined in Section 4.1.2.5 (Large Oil Spills). The Scenario assumes median large spills would be a 1,700 bbl pipeline spill, or a 5,100 bbl platform spill. Spills from platforms and pipelines could occur at any time of the year, and two large spills are assumed to occur during the lifespan of the Scenario.

Another assumption for large crude oil spills is that the spill could persist as a coherent slick for up to 30 days unless wind and wave action expedites the disintegration of the slick before 30 days. If a spill were to occur during winter and froze into sea ice, the slick could persist for 30 days after sea ice melts. Weathering processes would affect the actual volume of oil from a large spill that could potentially contact a Grouped Land Segment (GLS) (Table 4-3).

Conditional Probabilities

The following discussion summarizes conditional probabilities for summer or winter chances of contact from all LAs and PLs contacting GLSs important to terrestrial mammals (Table A.1-17; A.2-73).

Large Spills Summer

The primary GLSs where caribou go for insect relief (Section 3.2.5) are 143 (WAH), 152 (TCH), 156 (CAH), 163 (PCH), and 173 (Tuktoyaktuk/Cape Bathurst Caribou (TCB) (Table A.1-17). Large spills are estimated to contact GLSs 156, 163, or 173 <0.5%, within 30 or 360 days during summer or winter. Therefore, it is safe to assume there is very little chance of a large spill of any type affecting caribou from the CAH, PCH, or TCB. Caribou from the WAH (<5%) and TCH (1-7%) could be contacted; however, exposure could only occur when landfast ice is no longer present. Consequently a summer spill from nearshore PLs would have the highest conditional chance (≤7%) of contacting caribou insect relief area (GLS152) (Table A.2-15 and A.2-18 and A.2-39 and A.2-42).

GLSs 158 and 164 have been identified as important coastal habitat areas for muskox. The chance of a large spill contacting GLSs important to muskoxen are <5%.

For contacts ≥5% the OSRA model estimates a 6-13% chance of a large spill contacting GLS 148 (Kasegaluk Brown Bears) within 30 or 360 days during summer from LA 10, PL 3, or PL 6. GLS 146 (Ledyard Bay) has a 7% chance of contact from nearshore PL 3 at 30 and 360 days. GLSs 146 and 148 represent areas between Cape Lisburne and Wainwright, Alaska, where grizzly bears sometimes concentrate to feed on anadromous fish and marine mammal carcasses that wash ashore (Tables A.2-39 and A.2-42.

No GLSs for furbearers were identifiable through exhaustive literature searches, nor could LSs or ERAs be developed for furbearer species.

Large Spills Winter

No GLSs had a chance of contact ≥5% within 30 or 360 days (Tables A.2-63 and 66).

Spill Response

A direct consequence of spill response activities would be displacement of terrestrial mammals from oiled areas until the cleanup process is complete. Activities that could affect terrestrial mammals include air traffic, vessels operating in nearshore areas, and the presence of people working to remove spilled oil. Vessel and aircraft traffic associated with an oil spill response and cleanup may startle caribou, muskoxen, grizzlies, or wolves. Activities such as in-situ burning and animal rescue could displace animals from an oiled area, lessening the potential for those animals to contact oil. It is likely some bears and other scavenging mammal species could be disturbed while feeding on carcasses, potentially creating bear-human conflicts. Cleanup activities such as beach cleaning may be performed with a high degree of success using newer technologies (Painter, 2011), particularly if substrate is silty or sandy or if there is a layer of permafrost near the substrate surface. 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 could vary, with the extent of coastal area exposed to hydrocarbon contaminants, the scale and timing of a spill response, and pre-existing stresses animals were exposed to (insect relief period, nutritional status, etc.).

Development and Production (Years 26-50)

The effects of aircraft during the development and production phase of the Scenario would be consistent with what was described in the Exploration, Development, and Production phase (Years 10-25). Likewise, the use of vehicles and heavy equipment in onshore areas and activities would be the same as was described for the exploration, development, and production phase.

Accidental Oil Spills and Gas Releases

Oil spill characteristics and effects from small and large refined crude or condensate spills would be consistent with those described in the previous phases. In Year 31, the potential for dry gas releases could arise as gas production begins. Gas release assumptions include a 20 million cubic foot dry gas release due to a loss of well control, and two 10-20 million cubic foot releases from onshore pipeline ruptures (Section 4.1.2.5 and Appendix A). A natural gas release from a loss of well control is of little concern to terrestrial mammals because of weathering; the distances between Leased Areas and the coast would prevent contact with coastal areas.

In the event of an onshore pipeline rupture, there would be a short-term release of condensate lasting less than one day, that could extend downwind for about a half mi (0.9 km) and would quickly dissipate once the blowout or leak was stopped. Leak detection systems in a natural gas pipeline would automatically detect any leaks in the pipeline and close the pipeline isolation valves to seal off the affected section of pipeline until the leak could be repaired. Subsequent releases would almost entirely be in a vaporous form, which should rise into the atmosphere. If ignition were to occur in the vicinity of released gas and explosion could occur as the released gas combusts (Appendix A, Section A-6). Onshore gas releases would contact habitat for terrestrial mammals; however, no GLSs would be contacted based on the assumption pipelines would come ashore somewhere between Wainwright, Alaska and Barrow, Alaska. Terrestrial mammal GLSs along the Chukchi Sea coast are located south of the potential landfall area and GLSs for the TCH and CAH would remain outside pipeline routes from the Chukchi Sea Coastline to TAPS.

Production and Decommissioning (Years 51-77)

During the production and decommissioning phase of the Scenario, there would be flights between the coast and offshore production platforms on a regular basis; however, it is unlikely there would be an appreciable increase in onshore flights other than commuter flights into Deadhorse, Barrow, and Wainright, Alaska. Commuter flights generally fly at altitudes well above 1,500 ft (457 m) AGL and land at established airfields or airports. Consequently, any increases in commercial flights should not affect terrestrial mammals. Likewise, the use of vehicles and heavy equipment in onshore areas and activities would be similar to what was described in the exploration and development phase; however, there would be an ongoing need for maintenance and inspection vehicles along the pipeline right-of-way.

During decommissioning there would be a surge of heavy equipment and vehicle activity engaged in disassembling pipeline sections and transporting them from the area, and performing any reclamation activities deemed necessary. There would also be a corresponding increase in the number of aircraft flying personnel and supplies to camps engaged in decommissioning. There could be moderate effects to caribou and muskoxen from flights below 1,500 ft (457 m) AGL.

Accidental Oil Spill and Gas Releases

Small and large crude or condensate spills could occur until Year 53, at which time crude oil and condensate production would conclude (Figure 4-2). After Year 53, accidents would likely include gas releases, large diesel spills from tanks, and small spills of refined oil or fuel that could continue until Year 77. The characteristics and effects from small and large refined, crude or condensate spills and accidental gas releases would be consistent with those described in Section 4.1.2.5, Tables 4-1 through 4-3, and Figure 4-2, and Appendix A.

Small refined oil spills have the potential to occur during the Production and Decommissioning phase of the Scenario, and in conjunction with activities such as facility and platform construction and pipeline installation, and operations. Spill characteristics and effects would be consistent with those described for small oil spills in the Exploration phase.

Conclusion

Caribou and muskox would experience moderate effects from unmitigated aircraft noise and presence, vehicle noise and presence, heavy equipment noise and presence, camps, facility and infrastructure construction and decommissioning, and human presence and activity. With mitigations such as minimum aircraft altitudes of 1,500 ft (457 m) AGL, waste management at dumps, security and safety protocols around camps, timing stipulations such as winter pipeline construction, and by limiting the overall footprint of noise and activity on the ground, the effects to each terrestrial mammal species could be reduced to negligible impacts.

The most likely routes for terrestrial mammals to come into contact with a spill would be through large oil spills from onshore or nearshore pipeline segments. Small spills of refined oil would biodegrade through weathering before contacting shore, as would small crude oil and condensate spills. Large releases of gas from nearshore pipeline segments could contact the Chukchi Sea coastline; however, spilled gas would weather quickly with very little, if any, actually contacting

GLSs, or LSs that are important to terrestrial mammals. An onshore gas pipeline rupture could create an explosion if ignited, and such an explosion would have minor effects on caribou; their tendency to form groups, distributed across the landscape, makes it very unlikely any would be in the vicinity of a ruptured pipeline. Similarly, a ruptured gas pipeline should have negligible effects on grizzly bears, muskox, and furbearing mammals due to their low densities, small group sizes, and their widely dispersed distribution across the ACP and Brooks Range foothills, which makes their presence in the vicinity of a ruptured pipeline unlikely.

As previously stated, the effects of climate change would be ongoing. The magnitude of potential effects from the Scenario are not anticipated to change, but climate change could alter the food web, ecosystem processes, food availability, weather events, and life cycle timing, and consequently the distribution, activity, numbers of terrestrial mammals, and numbers of mammal species on the North Slope of Alaska.

4.3.8.2. Alternative II – No Action

Under Alternative II, Lease Sale 193 would not be affirmed and no leases would be available for further exploratory drilling or for development within the Chukchi Sea Leased Area. Exploration activities such as seismic surveys, which are not tied to leases, would continue. Impacts from vessel traffic and noise associated with various seismic surveys would continue. Impacts from exploratory drilling, pipeline route clearance, shallow hazard surveys, and activities related to on-lease exploration and production would not occur unless additional lease sales were held and leases issued at a later date. Selecting Alternative II would result in a lower level of impact to terrestrial mammals.

4.3.8.3. Alternative III – Corridor I Deferral

Alternative III provides the largest deferral area of the action alternatives – a corridor approximately 60 miles (97 km) wide along the Chukchi Sea shoreline. If Alternative III were selected, the distance from the shore to many activities could be greater than under Alternatives I and IV. No exploration or development drilling or platform construction would occur within the corridor, although certain activities (i.e., installation of a pipeline extending from the leases outside the corridor to the shore) could occur there. Of the Lease Sale 193 leases, only five are within Corridor I.

The minimum distance from shore under Alternative III could be slightly greater for the following than under the other action alternatives: length of pipeline from a platform to shore; travel distances from vessels and aircraft; source of discharges, emissions and noise from drilling and platforms; and, potentially the source of a large offshore oil spill.

The primary benefit of the corridor provided by Alternative III is that it could move potential sources of adverse effects farther away from important coastal habitats. The increased distance between offshore development and coastal habitats could slightly decrease the likelihood of spilled oil contacting onshore habitats; increase weathering of spilled oil prior to contact with onshore habitats; and increase available spill response time. Using the Impacts Scale in Section 4.2, the level of impacts under Alternative III would be consistent with the other action alternatives.

4.3.9. Vegetation and Wetlands

4.3.9.1. Alternatives I and IV

Impact Producing Factors

This section identifies the IPFs resulting from the oil and gas activities associated with the Scenario. It discusses the manner in which each identified IPF can affect vegetation and wetlands. IPFs are organized by phase of oil and gas activity (i.e., exploration, development, and production). IPFs which occur during multiple phases are addressed in the phase in which they first appear; these discussions are then referenced where applicable.

Because approximately 95% of the land on which the shore-based activities would occur is considered wetlands (Section 3.2.6), BOEM assumes that the IPFs that result in ground disturbance to vegetation also affect wetlands for the purposes of calculating impacts. Effects to vegetation/wetlands are analyzed.

Accidental spills, though not considered routine oil and gas activities, have the varying potential to occur during each phase: exploration, development, production, and decommissioning. A general discussion of the types of impacts of small and large spills are addressed in the activity phase where they first have the potential to occur. The impacts of oil spills or gas releases specific to this Scenario, within the larger context of all other activities that occur during each period of time, are then analyzed in the subsection "Impacts of the Scenario Through Time."

Exploration

Habitat Alteration

In the Scenario, activities associated with the exploration phase that would potentially affect vegetation/wetlands are those that physically alter the habitat and/or hydrology, including the following: construction of camps for shore-based facilities (exploration base, airbase, search and rescue bases, man-camps, and fuel storage pads), permanent and temporary road construction for access to various project facilities; expansion of existing material sources, or development of new material sources. The activities described below could be conducted in support of the Scenario and would result in direct and indirect alteration of wetland habitats. It should be noted that wetlands and waters of the U.S. are potentially subject to U.S. Army Corps of Engineers (USACE) jurisdiction under authority of Section 10 of the Rivers and Harbors Act (RHA) or under authority of Section 404 of the CWA. Section 10 of the RHA requires authorization for work in, over, or affecting navigable waters; Section 404 of the CWA requires authorization to place fill material into waters of the U.S., including wetlands.

Gravel mine. Development of new or expansion of existing gravel sites would cause both temporary and permanent loss of vegetation/wetlands. Typically, vegetation and overburden are removed and stockpiled on ice pads adjacent to the gravel mine. As the gravel is mined, it is stockpiled on a gravel pad near site. The potential impacts from the gravel and ice pads are analyzed further below. Excavation of the mine would result in the loss of the existing vegetation/wetlands within the mine footprint itself, as well as degradation and/or loss of wetlands adjacent to the mine. Gravel pits can fill with water over time, frequently requiring dewatering before they can be re-used. Water discharged to nearby areas generally does not have effects on vegetation/wetlands unless discharge rates are uncontrolled, which could result in localized erosion and loss of vegetation.

Placement of fill. Gravel fill for shore-based facilities directly covers and kills vegetation. Placement of gravel fill also has the potential to divert, impede, or block natural drainages in areas adjacent to the fill. In addition, effects associated with gravel fill for pads and roads include roadside dust, flooding, and thermokarst (NRC, 2003a). Most changes in plant communities around gravel pads and gravel roads would occur within about 165 feet (50 m) of the structure. These are analyzed further below.

Dust. The passage of vehicles over gravel pads and roads results in dust and gravel being sprayed over vegetation. Walker and Everett (1987) observed that the most heavy dust deposition is anticipated to occur within approximately 30 - 35 feet (10 m) of a road, with a noticeable dust shadow out to about 165 feet (50 m). Dust and gravel can smother vegetation if thick enough. Dust that covers snow surfaces can result in greater heat absorption, which can increase surface temperature and thaw depth near the gravel pad. The chemical composition of dust, as well as particle size, and deposition rate, all contribute to the impact on vegetation and wetlands (Walker and Everett, 1987).

Thermokarst and hydrological changes. 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 permafrost (NRC, 2003a, b). Thermokarst features (irregular depressions caused by warming, melting and heaving of frozen ground) would likely occur where gravel roads/pads cause changes in adjacent areas' moisture regime, natural drainage patterns, or snow-drift patterns (NRC, 2003a, b). Mosses promote low soil temperatures and permafrost development when weather is cool and moist, and insulate soils under warm, dry conditions (Oechel and Van Cleve, 1986). The loss of moss or other vegetation as a result of dust accumulation or other source of ground disturbance is partially responsible for the development of thermokarst features developed along older roads. Vegetation loss is also caused by increased snowdrift near gravel features. Snow drifts cause increased wintertime soil-surface temperature and increase thaw depth of soils, which can also alter species composition and cause thermokarst development. Finally, gravel roads/pads can block natural drainage patterns, potentially altering both the hydrology and species composition adjacent to the structure. In most cases, increased flooding leads to decreases in plant species richness (Rixen and Mulder, 2005).

Ice roads, ice pads, snow trails. Ice roads and ice pads could possibly be used for portions of the Scenario. Construction of ice roads, ice pads, ice airstrips, and snow trails could impact vegetation/wetlands through compression of vegetation. The length and severity of the impacts depends on the types of vehicles, vegetation types, and snow conditions. In general, vehicle tracks may affect vegetation, soil chemistry, soil invertebrates, soil thaw characteristics, and cause small-scale changes in hydrology (Kevan et al., 1995).

Noxious Weeds. There is the potential to introduce non-native plants and noxious weeds with heavy equipment used in construction, mining gravel material sites, and transportation of materials to various sites during any phase of the project. Non-native plant species, however, may lack physiological and morphological adaptations required to survive extreme Arctic conditions. Their growth and reproduction could be limited by extreme low temperatures in the soil and aboveground, short photoperiods, and sporadic midsummer freezes (NRC, 2003a, b).

Increased Public Access to Isolated Vegetation Communities. A long-term indirect effect of roads is the access they provide to areas of undisturbed tundra vegetation. A consequence of unstructured off-road traffic is an increased potential for impacts on otherwise isolated plant communities, as well as other fish and wildlife resources.

Accidental Oil Spills

Small Spills. Small Refined Spills (<1 bbl up to 50 bbl per spill, diesel, hydraulic fluids) have the potential to occur during exploration. Small spills could occur offshore during delineation activities, or onshore during construction of shore-based facilities. Small spills offshore may be contained on a vessel, on a platform, or onshore, or those spills reaching the water, may be contained by booms or absorbent pads. Therefore, direct disturbance on plant communities along the Chukchi Sea shoreline (saltmarshes, estuaries, sand-dune vegetation, and tundra wetlands) would be unlikely. The majority of small spills that occur on land are generally contained on gravel pads where the vehicles are refueled and construction activity is occurring.

Development

The activities described above as habitat alteration would increase as construction of the Scenario's shore-based facilities would result in direct and indirect alteration of wetland habitats. The development phase includes the construction of facilities to produce hydrocarbons and move them to market. The largest onshore development would likely occur during this phase with the winter construction of the oil pipeline, the development of additional gravel material sites and various project facilities. These activities would alter habitats, impacting vegetation and wetlands. Possible accidental oil spills and releases of gas would only be expected to occur offshore and not impact vegetation and wetlands. Impacts during the development phase from habitat alteration are the same as those described above for exploration activities. There are no new IPFs that would occur in this phase.

Accidental Oil Spills

Small Oil Spills. Small refined spills (<1 bbl up to 50 bbl per spill diesel, hydraulic fluids), analyzed above under exploration, during development activities would be refined products the same as small spills discussed during exploration.

Production

The production phase includes the production and transport of oil to market. Additional construction onshore would likely occur during this phase with the winter construction of the gas pipeline, and various project facilities. These activities could alter habitats, impacting vegetation and wetlands. Impacts during the development phase from the IPF 'Habitat Alteration' are the same as those described above for exploration activities. With the exception of the possibility of an accidental gas release, analyzed below, there are no new IPFs that would occur in this phase.

Accidental Oil Spills

Small Oil Spills. In addition to small spills (<1 bbl up to 50 bbl per spill diesel, hydraulic fluids) of refined products analyzed under exploration and development, small crude oil spills, condensate spills and gas releases could occur at the shore-based facilities and along the 300 mi pipeline. Spills occurring at the shore-based facilities and at pump stations would likely be contained or absorbed with pads. Accidental releases of gas would be of little consequence to vegetation and wetlands. Spills contained on gravel pads would not likely effect vegetation and wetlands. However, until the construction of the gas pipeline with the access road small spills along the 300 mi pipeline would cause direct disturbance on plant and wetland communities. The effects of spills vary depending on the season, hydrology, nature of the soil, vegetative community, and the amount and/or type of product spilled.

Large Oil Spills. In addition to small cude oil spills, production activities carry the risk of large crude oil spills (where large ≥1,000 bbl). Section 4.1.2.5 discusses the accidental oil spills and gas releases assumptions; this includes one large 1,700 bbl crude or condensate oil spill along the 300 mi pipeline occurring over the 77 years of the Scenario. Spills that saturate the tundra likely would be considered severe, with a vegetation recovery time of 10 years or more. In drier vegetation, the recovery time may be double or triple than vegetation in wetlands. In 1978 researchers indicated impacts from a large spill that saturate the soil with oil to a depth of more than 4 in (10 cm) have very slow recovery rates, and plant cover has been shown to be poor after 12 years (Walker et al., 1978). Subsequently faster rehabilitation of vegetation and wetlands occurs if spill cleanup was aided by use fertilizers (McKendrick, 2000).

If a large oil spill occurred 60 miles offshore, the probability of the spill reaching estuaries and saltmarshes along the Chukchi Sea would be very low because booms could be placed to protect sheltered embayments and streams. The probability of impacts on the estuaries and saltmarshes would depend on wind and wave conditions. When spills take place in open water, the potential for a quick response is higher. In situ booming and skimming operations would be effective means to prevent oil spills from reaching sheltered bays where estuaries and saltmarshes typically are found. If the spill occurred close to the shoreline, impacts could include the destruction of emergent vegetation if oil sinks into the root system. However, the Chukchi Sea shoreline is characterized by small tides and moderate regional winds (Section 3.1.2), creating a low potential for spilled oil to reach beyond the intertidal area. 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. Seasonal storm events could force oil into upper shoreline areas and inside delta areas (Reimnitz and Maurer, 1979). Oil deposition above the level of normal wave activity could 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.

BLM estimates during the 34-year North Slope oil industry history 20-35% of past oil spills (in this case, crude oil) have extended beyond gravel pads (USDOI, BLM, 2012). However, if oil is spilled on wet tundra, it can result in the mortality of the moss layers; fertilization following spill cleanup enhances moss recovery (McKendrick and Mitchell, 1978; McKendrick, 2000). The effects of spills vary depending on the season, hydrology, nature of the soil, vegetative community, and the amount and/or type of product spilled. Oil flowing over land can infiltrate vegetative cover, soil, and snow (USDOI, BLM, 2012). The BLM also indicates spills during summer can penetrate the active layer of soil and rock that thaws each summer and overlies the permafrost, and then spread laterally on the frozen subsurface.

Accidental Gas Releases

The Scenario estimates two 20 million cubic feet releases occur onshore from the 300 mi gas pipeline. USDOI, BLM (2012) analyzed a single gas release could have thermal effects to approximately 194 acres of tundra vegetation (500-meter radius), if ignition occurs. Similar to the BLM analyses, if ignited, the assumed number of two gas releases would result in thermal effects to approximately 466 acres of vegetation. BLM further computed if a wildfire resulted, additional acreage would burn, the amount depending on season, weather conditions, moisture content of vegetation, and suppression effort. Racine and Jandt (2008) reported most North Slope tundra fires are less than 1,000 acres. Following lightning-caused tundra fires the total vascular plant cover reached 50−100% after 5 to 6 years (Racine et al. 1987). If lichens can achieve former densities at all under a climate-warming regime, then it would take several decades for lichens to recover (Jandt et al., 2008).

Impacts of the Scenario through Time

This section provides analysis of impacts to vegetation and wetlands resources as they occur through the 77 years of the Scenario. This analysis addresses the particular oil and gas activities that would occur during each relevant time period and analyzes their impacts against the backdrop of a dynamically affected environment. Whereas previous sections have focused on identifying relevant IPFs and the types of environmental impacts they may cause, this section more specifically accounts for the level at which each IPF occurs during a given phase, the overlap of IPFs, and any additive or synergistic impacts which may result. In total, these sections tell the story of how the activities comprising the Scenario would affect vegetation and wetlands resources through time. Meanwhile, the effects of climate change would be ongoing. Shifts in plant species are anticipated to occur during the life of the Scenario. In some areas, plant communities may shift towards increases in the areal extent of shrubs and greater shrub height (Chapin et al., 1995, Walker et al., 2006); other areas may experience shifts towards increased grass and sedge species and decreases in graminoids (Anderson and Weller, 1996). In addition, warmer soil temperatures are likely to increase frequency thermokarst, and increases in sea level may inundate low-lying tundra areas. Changes in the hydrology of wetlands, ponds, and lakes are anticipated to occur.

Exploration (Years 1-5)

Exploration includes those activities conducted to acquire information about the location, size, and characteristics of oil and gas prospects within the area of leasing. This includes activities conducted to acquire information about potential drilling locations, e.g. surveys to describe seafloor characteristics and/or locate drilling hazards. This also includes exploration and delineation well drilling. Because these activities would be conducted offshore, there would be little to no effect on vegetation/wetland communities. However, construction of the shorebase or coastal facilities would begin during this phase.

Shore-based facility construction is anticipated to occur during Years 1and 2, and effects on vegetation/wetlands are expected as a result of these activities. It is estimated that a total of approximately 340 acres (137 ha) of sedge/moss/dwarf shrub wetlands (W2 type from Section 3.2.6) would be altered via the IPFs described above. It is anticipated that gravel would be obtained from a material site near the village of Wainwright or Barrow. The Scenario indicates that most of the coastal facilities (also called the shore-base) construction would be expected near Wainwright or Barrow, and includes the direct impacts:

- Approximately 15 acres (6 ha) would likely be filled for an exploration camp.
- Approximately 5 acres (2 ha) would be filled to expand the existing airport at Wainwright to support cargo (e.g., C-130 Hercules) and commercial airlines (e.g., Boeing 737).
- Approximately 7 acres (2.8 ha) would be filled to construct a search and rescue base with a helipad and a road connection to the village of Wainwright or Barrow.
- Approximately 72 acres (29 ha) of ground disturbance, in addition to the areas fill above, is likely on (for other coastal facilities which include the placement of gravel and fill material such as an onshore production base, and pump station).
- Construction to support production would begin during Year 5. The exploration base camp would be converted into the residential portion of the production camp. The production base would expected to be composed of the landfall valve pad with protective ice berm, valve enclosure control building, pipeline riser well, onshore pipeline trench and backfill, a pump station, pipeline pigging facilities, a land-farm for barged drilling waste treatment. The supply boat terminal would include the barge dock with lay-down area and material storage, fuel tank farm, and vehicle parking.
- Construction for the shore-based facilities would require gravel. Gravel would be obtained from a potential material site approximately 240 acres (97 ha) in size.

There would be indirect impacts of the fill activities expected during the construction of the shore-based facilities. These impacts would affect the composition and density of the surrounding vegetation and wetlands; these impacts would continue and compound from maintenance and snow removal over the entire period of the Scenario. A heavy spray of dust and gravel will accumulate and cover an area of approximately 26 additional acres (approximately 10 ha) impacted within 10 m of the edge of the fill placed for pads, runways extension, and roads. Additionally from about 30 to 35 ft (approximately 10 m) beyond edge of the fill to about 165 ft (approximately 50 m) from the adjacent fill a dust shadow would be evident and estimated would affect about 114 acres (approximately 46 ha).

Accidental small spills would have negligible impacts; this includes possible spills at the shorebase, offshore in the Chukchi Sea, and at a refueling barge in Kotzebue Sound (approximately 50 bbl). The offshore small oil spills would likely be during geological and geophysical activities. Small spills offshore may be contained on a vessel, on a platform, or onshore. Those spills reaching the water may be contained by booms or absorbent pads. The NRC (2003a) reported many small spills have occurred in the oil fields, but they have not been frequent or large enough for their effects to have accumulated. Their impacts include gravel contamination, which is difficult to clean up and makes the gravel unavailable for rehabilitation.

Conclusion

Approximately 340 acres of wetland habitat would be directly excavated, filled, or degraded as a result of shore-based activities during this time period. Impacts from a gravel spray and dust shadow would indirectly impact approximately 140 acres (approximately 57 ha). Impacts would be localized. Small spills would likely occur. The effects of these spills would generally be localized and cleaned up quickly. Overall, the impacts to vegetation/wetland communities from this phase range from negligible (for routine oil and gas activities) to minor (in the event of a small oil spill, because impacts would be short-term and localized). Simultaneously, the effects of climate change would be ongoing. The magnitude of potential effects from the Scenario are not anticipated to change, but climate change could alter composition of the affected plant communities, affect the recovery of plant communities to their original composition, and exacerbate potential hydrological changes of wetlands and other water bodies.

Exploration and Development (Years 6-9)

Exploration activities continue throughout this period. This period would have an overlap of development with exploration. Construction that began on the coast with ground disturbance during the exploration phase would be completed during the development phase, which begins in Year 6. Discovery of an anchor field phase precipitates the development of infrastructure necessary to produce oil. A shorebase and a supply boat terminal are likely to be constructed in Years 5 and 6. Installation of 300 miles (482 km) of onshore oil pipeline and 160 miles (257 km) of offshore pipeline occurs from Years 6-9. Oil pipelines buried under tundra have been the exception on the North Slope rather than the norm, since oil must be heated to be transported efficiently. Consequently, it is anticipated that an above-ground oil pipeline would be constructed, which would require development of vertical support members (VSMs).

Offshore. There would be limited impacts from offshore pipeline construction to vegetation/wetlands with the two possible exceptions: connecting the subsea pipelines at the landfall valve pad and an anticipated expected high activity level at the shorebase would support construction of the subsea pipelines.

Onshore. A high activity level at the shorebase is expected due to the offshore pipeline construction and would cause some effects to vegetation and wetlands that include the generation of dust and continued damages to adjacent vegetation cover.

Year 6 of this exploration and development period would also be the first of 4 years of winter construction expected to build the 300 mi (483 km) oil pipeline and associated facilities in the pipeline right-of-way. Potential negative impacts on vegetation communities and wetlands could be caused by the winter construction of the 300 mi (483 km) pipeline. Approximately 3,640 acres (1,473 ha) would be impacted from the development of gravel material sites and construction of 100-foot-wide (30 m) gravel pads along the 300 mi (483 km) pipeline corridor. It is anticipated that ice roads would be used to accomplish the oil pipeline construction during winter months. If so, approximately 3,600 acres (1,097 ha) of wetlands could be damaged. If appropriate impact avoidance and minimization techniques are employed, these wetlands would likely recover over time. Wetland construction impacts would be minimize and mitigated through the efforts of the BLM and the Corps of Engineers. Each agency has jurisdiction. The 300 mi pipeline would cross the NPR-A, and the BLM would require pipeline right-of-way stipulations. The Corps of Engineer would condition their permit authorization and also require mitigation for the onshore development.

If permanent access is needed to the pipeline, then a 15 foot (4.6 m) wide access road would likely be constructed parallel to the pipeline, within the assumed 100 foot (30 m) wide right-of-way. Approximately 1,275 acres (516 ha) could be filled based upon the road length of 300 miles (483 km) along with a 35 foot (11 m) disturbance footprint. Indirect impacts from the construction and maintenance of the road include a heavy spray of dust and gravel would accumulate and cover an area of approximately 2,385 acres (approximately 965 ha) impacted within 10 m of the edge of the fill placed for pads, runways extension, and roads. Additionally, from about 30 to 35 ft (approximately 10 m) beyond edge of the fill to about 165 ft (approximately 50 m) from the adjacent fill a dust shadow would be evident and estimated would affect about 9,542 arces (approximately 3860 ha).

Other impacts during the 300 mi (483 km) pipeline construction include loss of vegetation/wetlands from backfill at VSMs, and fill material to construct valve pads, pads for spill equipment containers at each stream/river crossing, pads at pipeline crossings, and potentially two pump stations along the corridor.

The impacts on tundra wetlands for the overlapping construction at the shorebase were accounted for and analyzed above in the Exploration (Years 1-5) section. Construction of offshore pipelines would start during Year 6 and is expected to be completed during Year 9.

Potential impacts from onshore development have not changed since the 2007 FEIS analysis and the 2011 SEIS; however, the geographic extent is more narrowly defined and is less variable than it was in the 2007 FEIS and 2011 SEIS (see Figure 4-11).

- The direct effects during the 300 mi (483 km) pipeline construction would likely result from placing backfill at: VSMs (approximately 9 acres or 4 ha), and fill material to construct valve pads, pads for spill equipment containers at each stream/river crossing, pads at pipeline crossings (approximately 29 acres or 12 ha), and potentially three pump stations along the corridor (approximately 150 acres or 60 ha).
- The 300 mi (483 km) pipeline construction would have localized impacts that are indirect and would not affect the functions of wetlands at a regional scale.
- There would be minor impacts on vegetation and wetlands along the 300 mi (483 km) pipeline route. These impacts would be localized and would include loss of tundra acreage, damage to vegetation cover, shift in species composition, and introduction of noxious weeds. Some negligible construction impacts caused by the connecting the subsea pipelines to the shorebase could result to vegetation and wetlands at the landfall valve pad. The potential for small refined spills (<1 bbl up to 50 bbl per spill diesel, hydraulic fluids) continues in the Exploration and Development period. These spills could occur during exploration (described above) or during early development activities, i.e. facility construction and pipeline installations.

Indirect impacts of the fill activities that would be expected during the construction and maintenance of the pump stations, valve pads, and river crossings would affect the composition and density of the surrounding vegetation and wetlands; these impacts would continue and compound from maintenance and snow removal over the entire period of the Scenario. A heavy spray of dust and gravel will accumulate and cover an area of approximately 57 additional acres (approximately 23 ha) impacted within 10 m of the edge of the fill placed for the pads. Additionally, from about 30 to 35 ft (approximately 10 m) beyond edge of the fill to about 165 ft (approximately 50 m) from the adjacent fill a dust shadow would be evident and estimated would affect about 94 arces (approximately 38 ha).

Conclusion

This time period involves the same activities as the exploration phase, but impacts increase due to pipeline construction. Vegetation/wetlands would be affected by construction of onshore pipelines (approximately 3,600 acres) and attendant facilities as a result of: filling and/or excavation, degradation from ice roads/pads, introduction of dust, thermokarst, flooding and/or desiccation, introduction of noxious weeds, shifts in species composition, and increased disturbance from increased public access. Indirect impacts of the fill activities that would be expected during the construction and maintenance of the pump stations, valve pads, and river crossings would continue and compound from maintenance and snow removal over the entire period of the Scenario; these would include about 151 acres (approximately 61 ha). The direct impact of road construction would be the filling of 1,275 acres (approximately 516 ha) of vegetation and wetlands. The indirect impacts from road construction and maintenance would include gravel spray and dust shadow would indirectly impact approximately 11,927 acres (approximately 4,827 ha). Overall, the activities conducted during this time period are anticipated to have a negligible to minor (short-term and localized) impacts on vegetation and wetlands. Simultaneously, the effects of climate change would be ongoing. The magnitude of potential effects from the Scenario are not anticipated to change, but climate change could alter composition of the affected plant communities, affect the recovery of plant communities to their original composition, and exacerbate potential hydrological changes of wetlands and other water bodies.

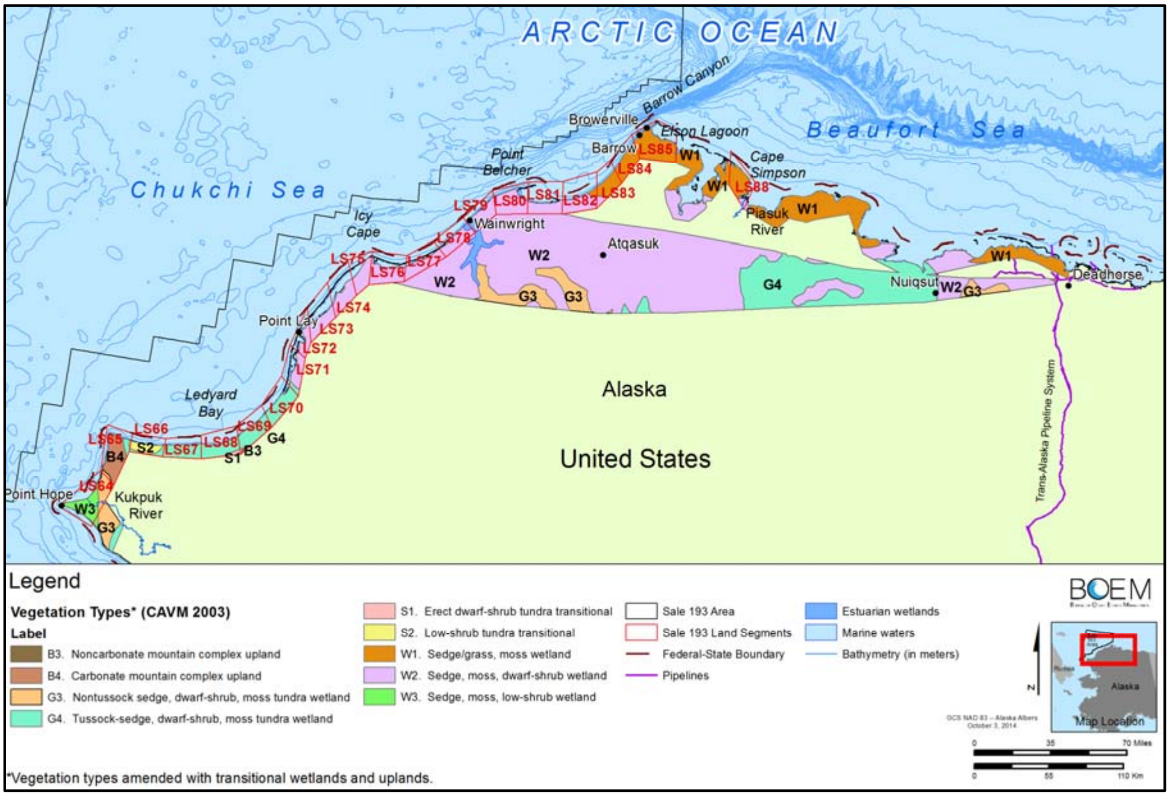


Figure 4-11. U.S. Alaska Coastal Wetland Vegetation Types with Land Segments. ***Vegetation and wetlands and the Land Segments identified in the oil-spill analyses that could be impacted.***

Exploration, Development, and Production (Years 10-25)

Exploration activities and development of the anchor field continue during this phase. Production of oil commences, meaning three categories of oil and gas activities – exploration, development, and production activities – occur during this period; however, construction started during earlier phases would likely be completed in Year 9. Production is expected to impact vegetation and wetlands less than during earlier phases. Negligible impacts to wetlands and vegetation, including habitat alteration, would likely result from dust generated by vehicle support of onshore maintenance of facilities. With the start of production, oil would also begin to be transported through the subsea and 300 mi (483 km) pipeline.

The potential for small refined spills <1 bbl up to 50 bbl per spill diesel, hydraulic fluids) continues in this phase. These spills could occur during exploration (described above) or during early development activities, i.e. facility construction and pipeline installations. In addition to the small refined spills a 700 bbl crude oil spill could occur along the onshore pipeline route. The effects of spills vary depending on the hydrology, nature of the soil, season, whether the soil is saturated during the winter, timing of spill during summer versus winter, composition of the vegetative community, the amount of crude oil spilled, the location of the spill, and how quickly personnel can begin oil-spill containment and cleanup activities.

In addition to small refined spills, in Year 10, as oil development and production begin in earnest, large (≥1,000 bbl) oil spills could occur. It is assumed that two large oil spills (a pipeline spill of 1,700 bbl crude or condensate oil, and a platform spill of 5,100 bbl crude, diesel or condensate oil) could occur during the entire life of oil development and oil production activities. In the event of a large oil spill, potential effects from oil spills in both the exploration and development phase would occur from oiling of vegetation and wetlands, disturbance or destruction from activities associated with oil-spill response and cleanup operations in the event that a large spill occurs. Mosses and aboveground parts of vascular plants will be killed by oil spills if there is a layer of water protecting the roots; all vegetation would be lost in dryer areas when oil is able to impact plant roots (McKendrick and Mitchell, 1978). Use of fertilizers will expedite recovery of the vegetation; however, length of time for recovery would be dependent upon soil moisture and the concentration of the product spilled (McKendrick, 2000). Without a thorough cleanup and rehabilitation complete vegetation recovery is expected within 20 years on a wet sedge meadow without any cleanup. However, the likelihood of a large spill reaching coastal wetlands along the Chukchi Sea would be very low. If the spill occurred close to the shoreline, the probability of impacts on the coastal wetlands would depend on wind and wave conditions. When spills take place in open water, the potential for a quick response is higher. Skimming operations would be effective means to prevent oil spills from reaching sheltered bays where wetlands typically are found. Due to the low tidal range typical in such environments, stranded oil would be subject to low rates of abrasion and dispersal by littoral processes.

Conditional probabilities for a large crude spill have been estimated, and show contact to vegetation and wetland at land segments along the U.S. and Russian coasts. See Section 3.2.6, for the complete names of the abbreviated vegetation types used below. The following discussion summarizes all LAs and PLs during summer or winter (two large spills) unless otherwise specified.

Summer Spill. The OSRA model estimates that the chance of a large spill contacting LSs with vegetation and wetlands within 30 days or 360 day ranges from <0.5-10% (Table A.2-33 and 36).

Russian Coast. A large spill has ≤2% chance of contacting individual LSs with a chance of contact to individual LSs 5-8 on Russia's Wrangel Island and LSs 21-37 along the northern shore of the Chukotka Peninsula (Map A-3a). The Russian LSs includes the following vegetation types: the Wrangel Island portion has G1 wetlands, and the eastern shore has G2 transitional wetlands to uplands. The Russian Chukotka Peninsula's northern shore from Pil'khikay to Utkan and Chegitun, including Kolyuchin Bay contains G2 transitional wetlands to uplands, G3 wetlands, S1 transitional wetlands to uplands, S2 transitional wetlands to uplands, and W2 wetlands (Figure 4-12).

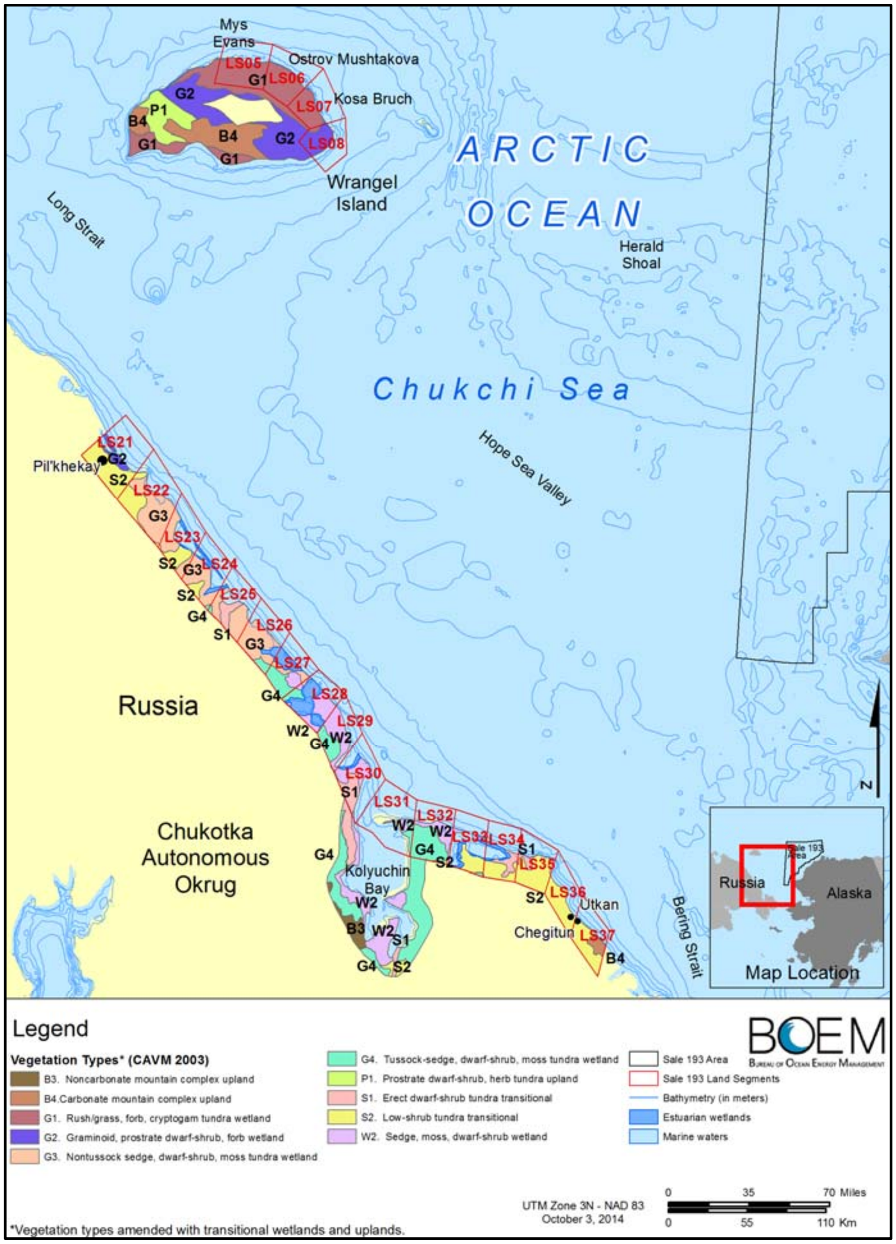


Figure 4-12. Russia Coastal Wetland Vegetation Types with Land Segments. ***Figure shows the vegetation, wetlands, and Land Segments identified in the oil-spill analyses that could be impacted.***

U.S. Coast. A large spill has ≤10% chance of contacting in the mouth of Kukpuk River near Point Hope to Barrow/Browerville and Elson Lagoon (LSs 64-85) and Cape Simpson, Piasuk River (LS 88; Map A-3b). These LSs include the following vegetation types: B4 uplands, G3 wetlands, G4 wetlands, S2 transitional wetlands to uplands, W1 wetlands, and W2 wetlands (Figure 4-11). The portion of Alaska's coast that could be contacted extends from western to north-central.

Winter Spill. The OSRA model estimates the chances of a large spill contacting LSs with vegetation and wetlands. The chance of contact to all Russian and U.S. coastal LSs (LSs1, 3-10, 12, 15-39, 64-67, 72-86) within 30 days ranges from <0.5-4% (Table A.2-57) and from <0.5-5% for within 360 days (Appendix A, Table A.2-60, Map A-3a and Map A-3b.).

Conclusion

Effects from construction of the 300 mi (483 km) oil pipeline and attendant features would persist across seasons. Effects of small accidental spills would be similar to those analyzed above. Most of the Russian and U.S. shoreline of the Chukchi Sea has a 30 to 40 foot (9-12 m) average rise above sea level; further inshore, the non-vegetated beaches lead to cliffs, above which lie the coastal vegetation and wetlands on the Arctic Coastal Plain (Section 3.1.1).The effects of large spill on coastal vegetation and wetlands would have minor impacts (short-term and localized). Inlets, rivers and bays, if subjected to crude oil, would be expected to have major (long-lasting, widespread, but less than severe) impacts to vegetation and wetlands. Simultaneously, the effects of climate change would be ongoing. While the magnitude of potential effects from the Scenario are not anticipated to change, the effects of climate change could alter composition of the affected plant communities, affect the recovery of plant communities to their original composition, and exacerbate potential hydrological changes of wetlands and other water bodies.

Development and Production (Years 26-50)

This period features additional development of the satellite field and the continuation of oil production from both the anchor field and satellite field. As oil production from wells on the anchor field declines, existing oil production platforms and wells are converted to natural gas production and wells. Installation of both offshore and onshore gas pipelines would begin during Years 27-29. It is anticipated that the 300 mi (483 km) gas pipeline (38 to 50 inch (96-127 cm) diameter) would be buried adjacent to the 300 mi (483 km) oil pipeline, placed in a trench approximately 12 foot (3 m) wide, and backfilled with the material from the trench. This would include the construction of an access road with a footprint approximately 35 foot (10.1 m) wide. These facilities would be within the 300 mi (483 km) long, 100 foot (30.5 m) wide right-of-way.

Trench excavation for the 300 mi (483 km) gas pipeline trench would likely disturb approximately 436 acres (approximately 176 ha) of vegetation and wetlands. These would likely reestablish over and adjacent to the pipeline after the block of frozen overburden would be replaced over the gas pipeline. Heavy equipment would be expected to operate on ice roads approximately 25 to 35 feet (8 to 12m) wide parallel to the trench, impacting approximately 1,300 acres (526 ha). The materials for the gas pipeline and blocks of frozen soil removed from the trench would likely on both sides of would impact. If a permanent access road was not constructed during the exploration and development, during Year 6 to Year 9, then it would likely be constructed along with the 300 mi gas pipeline during development and production. The areas of direct and indirect impacts of the road have been discussed above. Those vegetation and wetlands would be permanently lost in order to accommodate long-term access and maintenance of the 300 mi (483 km) oil and gas pipeline. Vegetation and wetlands over the 300 mi (483 km) gas pipeline would be re-established, though they could continue to be impacted by dust generated by road use and maintenance activities.

Without ignition, gas releases either offshore or onshore would not impact vegetation. The BLM (2012) analysis of a gas release with ignition on land indicates thermal impacts to vegetation and wetlands in the vicinity of a release (Racine, Johnson, and Viereck, 1987 in USDOI, BLM, 2012). Vascular vegetation would be impacted for 5-6 years and lichens could be impacted for several decades (Jandt et al., 2008 in USDOI, BLM, 2012).

Conclusion

Effects from the 300 mi (483 km) gas pipeline installation and possible access road construction, include disturbance/displacement along the 300 mi (483 km) oil/gas pipeline route and other attendant features. There would be 436 acres of vegetation and wetlands impacted during the development and production years. These impacts would persist across seasons. Overall, the activities conducted during this time period are anticipated to have minor impacts. Effects of accidental spills – both large and small - would be similar to those analyzed above. As stated above, the effects of climate change would be on-going. While the magnitude of potential effects from the Scenario are not anticipated to change, the effects of climate change could alter composition of the affected plant communities, affect the recovery of plant communities to their original composition, and exacerbate potential hydrological changes of wetlands and other water bodies.

Production and Decommissioning (Years 50-77)

The final period is characterized by end of oil production, declining gas production, and decommissioning of infrastructure associated with each. As wells reach the end of their economic lives, they are taken offline and plugged with cement. Platforms would be removed and pipelines would be decommissioned. Production of oil ends in Year 53. Activities at the shorebase would increase to support the decommissioning of the gas pipelines.

During this phase, there are brief periods of construction activity that would have localized, short-term effects; however, the footprints of existing facilities in the terrestrial environment would continue to result in permanent loss of vegetation/wetlands. Operation and maintenance of existing infrastructure, such as the pipeline corridor and other facilities, could continue to degrade adjacent wetlands via generation of dust, increase possibility of thermokarst, introduce noxious weeds, and increase public access. Effects of accidental spills – both large and small - would be similar to those analyzed above.

Conclusion

The primary IPFs that would affect vegetation/wetlands are habitat alteration and accidental oil spills (small and large). During construction, there would be localized, short-term effects; however, the footprints of some facilities in the terrestrial environment would result in permanent loss of vegetation/wetlands in the NPR-A. As stated above, the effects of climate change would be ongoing. While the magnitude of potential effects from the Scenario are not anticipated to change, the effects of climate change could alter composition of the affected plant communities, affect the recovery of plant communities to their original composition, and exacerbate potential hydrological changes of wetlands and other water bodies.

Overall Conclusion

The expected direct impacts to vegetation and wetland resources for the entire Scenario timeline are negligible to minor for routine construction and maintenance of the oil and gas activities. The expected indirect impacts on vegetation and wetlands resulting from oil development and production would be negligible to minor, because they would be localized. These direct and indirect impacts could be moderate when compounded with a large accidental oil spill (up to 1,700 bbl) during Year 20 to Year 53, or a large accidental gas release would occur during Year 31 to Year 74. These impacts would not have a severe effect on the ecological functions, species abundance and composition of wetlands and plant communities of the North Slope. The impacts analysis on vegetation and wetland includes mitigation discussed below, since the Corps of Engineer regulatory actions would be required for activities in wetlands and since the Scenario has a major portion of area within the NPR-A and would require BLM right-of-way actions. Overall, impacts of routine activities in the Scenario on vegetation and wetlands are expected to range from negligible to minor, due to short-term, localized effects on ecological functions, species abundance and composition of wetlands and plant communities. The potential impacts from large oil spills would range from minor to moderate, depending the location and effectiveness of response measures.

Mitigation

The following mitigation measures could be implemented on a site-specific basis when feasible to ensure protection, to the greatest extent practicable, of tundra vegetation and wetlands. The above analyses of impacts to vegetation and wetlands are based upon measures expected to minimize and mitigate those impacts. Wetland construction impacts along with activities to prevent spills and rehabilitation of spill impacted areas would be minimized and mitigated through regulatory actions by the BLM and the Corps of Engineers. Each agency has jurisdiction. The 300 mi pipeline would cross the NPR-A, and the BLM would require right-of-way stipulations, required operating procedures, and best management practices (Table 2-3 of the National Petroleum Reserve in Alaska (NPR-A) Final Integrated Activity Plan/Environmental Impact Statement (BLM, 2012)). The Corps of Engineers would condition their permit authorizations with general conditions, special conditions, and also require mitigation for wetland impacted. The necessity for and effectiveness of the potential mitigation measures below would be dependent on the specific activities proposed and the particular location involved.

- Critical wetlands and sensitive areas would be identified, and construction of facilities would be avoided in such areas.
- Oil-spill-prevention and -control plans and contingency actions would be prepared to address prevention, detection, and cleanup of oil spills.
- Pipeline leak-detection systems would include the use of pigs (bullet-shaped devices that slide through pipelines to look for corrosion). Pig runs would be implemented systematically.
- Impacts would be minimized by restricting winter and summer off-road traffic, and road layout would be coordinated with standards.
- Gravel extraction would be conducted during winter. Transport and construction activities would be conducted using ice roads and ice pads.
- During winter construction, using low-ground-pressure vehicles, avoiding areas with low snow cover, and decreasing the amount of vehicular traffic could help minimize damage.
- Overlaying material covering gravel borrow pits would be removed and set aside in overburden stockpiles. The organic-rich silt referred as “tundra sod” would be separated and stockpiled for later use in land rehabilitation.
- Gravel pits could fill with water and shaped to provide appropriate depths along pond fringes to create the right conditions for emergent and aquatic vegetation growth (critical component in creating fish and waterfowl habitat).
- To prevent vegetation impacts related to thaw of the permafrost zone, gravel pads would be built over 1.8 m thick and, if needed, polyethylene insulation would be placed below the pads to reduce the amount of gravel necessary.
- Techniques to rehabilitate thick gravel pads could include reusing tundra sod by spreading it on gravel pads to improve productivity, sustain long-term plant growth, and allow for the establishment of a broad range of plant species.
- The creation of berms to capture drifting snow, modification of gravel pads’ hydrologic balance, and the addition of soil amendments would increase water retention and mulch to reduce evaporation (Jorgenson and Joyce, 1994).
- Gravel-pad restoration would include the use of nitrogen-fixing arctic native legumes (*Astragalus alpinus, Hedysarum alpinum, H. mackenzii, Oxytropis borealis, O. campestris*, etc) and other native species.
- The removal of gravel pads and remediation of contaminated soils would be used when feasible.
- Bioremediation techniques would be used, if necessary, to accelerate vegetation recovery in areas affected by large spills.
- Mitigation measures for an offshore large spill would include the protection of sheltered saltmarshes and estuaries with booming and skimming operations, if climatic conditions permit.

- Manage the 300 mi winter construction on ice roads such that the 300 mi gas pipeline and access road are eventually constructed on over the area previously impacted by ice roads.
- After completion of gravel mining activities at the gravel material sites, relevant permitting agencies typically require rehabilitation of the mined site. Rehabilitation would include replacement of overburden, contouring the shoreline, and stabilizing side walls. Some gravel mines on the North Slope have been rehabilitated (NRC, 2003a), but the end product has produced mixed results. Also, the rehabilitated gravel pit provides primarily fisheries habitat, not vegetation wetland tundra.

If properly implemented, BLM's right-of-way stipulations and required operating procedures should effectively reduce the impacts of development on vegetation and wetlands. The operating and maintenance procedures that regulate solid and liquid-waste disposal, fuel handling, product transportation, and spill cleanup would be expected to reduce the potential effects of intentional releases, spills, and solid waste on vegetation and wetlands. Required setbacks and avoiding critical wetlands and sensitive areas associated with development near rivers, lakes, and other specified habitats would minimize impacts in high-value wetlands, riparian habitats, and floodplains. Impacts to vegetation and wetlands would be minimized with winter construction expected to be required by the Corps of Engineers and BLM, and if permitted by BLM, off-road summer transportation. Expected Corps of Engineers special conditions and the BLM right-of-way stipulations and required operating procedures affecting development, such as facility design and construction of pipelines, roads, drill pads, airstrips, and other facilities, are expected to minimize the amount of habitat that would be altered by gravel pads, gravel extraction, creation of berms for hydrological balance, placement and separation of overburden, placement of gravel stockpiles, and other surface disturbances. Other requirements would facilitate the regrowth of native vegetation following decommissioning.

4.3.9.2. Alternative II – No Action

Under Alternative II, Lease Sale 193 would not be affirmed and no current leases would be available for further exploratory drilling or other oil and gas development within the Chukchi Sea Leased Area. Impacts from the Scenario on vegetation and wetlands from construction of land-based facilities needed to support exploration and subsequent production, such as camps, roads, gravel sources, oil/gas pipelines, and other project features, would not occur. Consequently, selection of Alternative II would result in no impact to vegetation and wetlands.

4.3.9.3. Alternative III – Corridor I Deferral

Alternative III provides the largest deferral area of the action alternatives – a corridor approximately 60 miles (97 km) wide along the Chukchi Sea shoreline. Of the Lease Sale 193 leases, only five are within Corridor I. If Alternative III were selected, the distance from the shore to many activities could be greater than under Alternatives I and IV. No exploration or development drilling or platform construction would occur within the corridor, although certain activities (i.e., installation of a pipeline extending from the leases outside the corridor to the shore) could occur there.

The minimum distance from shore under Alternative III could be slightly greater for the following than under the other action alternatives: length of pipeline from a platform to shore; travel distances from vessels and aircraft; source of discharges, emissions and noise from drilling and platforms; and, potentially, the source of a large offshore oil spill.

The primary benefit of the corridor provided by Alternative III is that it could move potential sources of adverse effects farther away from coastal vegetation and wetlands. The increased distance between offshore development and coastal habitats could slightly decrease the likelihood of spilled oil contacting onshore habitats, increase weathering of spilled oil prior to contact with onshore habitats, and increase available spill response time. Using the Impacts Scale in Section 4.2, the level of impacts under Alternative III would be consistent with the other action alternatives.

4.3.10. Economy

4.3.10.1. Alternatives I and IV

The structure of this analysis differs from that of other resources in this chapter because the economy is primarily affected by the exploration, development, production, and decommissioning activities themselves, not the IPFs associated with those phases. The activities associated with oil and gas development and production in the Chukchi Sea would generate economic activity manifested primarily in employment, personal income, and revenues to the government. The economic effects would be in the North Slope Borough (NSB), the rest of Alaska, and the rest of the U.S. The Scenario described in Section 2.3 is the basis for analysis for potential economic effects in this section. The reader should refer to that section for details on the timing of OCS activities, including development of infrastructure assicoated with wells, MODUs, platforms, pipelines, and shore-based facilities. The activities, construction, and operation of infrastructure required to explore, develop, and produce 4.3 billion bbl of oil and 2.2 tcf of natural gas over 77 years in the Chukchi Sea described in the Scenario generate employment, labor income, and revenues.

Impact Producing Factors

The NSB is a mixed cash-subsistence economy. This section discusses economic impacts from potential oil spills and gas releases in terms of traditional measures of employment, income, and revenues. For analysis of potential impacts to subsistence-harvest patterns, communities, and sharing networks, please refer to Section 4.3.11, Subsistence-Harvest Patterns.

Activities that require manpower and development of onshore infrastructure are the primary IPFs that drive economic impacts as measured by employment, labor income, and revenues. Of the five IPFs described in Section 4.1.2 - noise, physical presence, discharges, habitat alteration, and oil spills - only oil spills are considered to generate economic impacts, as oil-spill response and cleanup would involve additional worker requirements and potential development of additional onshore infrastructure to support cleanup activities. Noise, physical presence, discharges, and habitat alterations by themselves do not generate economic activity; it is the exploration and development activities that generate noise, presence, discharges, and habitat alteration that generate economic activity. Therefore, the following discussion of IPFs focuses only on economic impacts from accidental oil spills or gas releases.

This discussion of employment, income, and revenues for oil-spill response is based on the most relevant historical experience of a spill in Alaskan waters, the Exxon Valdez Oil Spill (EVOS) of 1989. That spill was 240,000 bbl. It generated substantial employment of up to 10,000 workers doing cleanup work in relatively remote locations. Smaller numbers of cleanup workers returned in the warmer months of each year following 1989 until 1992. The EVOS also had effects on jobs and income associated with commercial and recreational fishing. During the EVOS, numerous local residents quit their jobs to work on the cleanup, often at significantly higher wages. This generated a sudden and significant inflation in the local economy (Cohen, 1993). Similar effects to 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. Additional housing and infrastructure may be needed to support the influx 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 cleanup efforts. This analysis assumes that any additional infrastructure built onshore would also be an enclave.

In the event of small or large oil spills, the number of workers employed for cleanup would depend on several factors. These include the procedures called for in the Oil-Spill Response Plan (OSRP), how well-prepared with equipment and training the entities responsible for cleanup are, how efficiently the cleanup is executed, and how well coordination of the cleanup is executed among numerous responsible entities.

Exploration

Accidental Oil Spills

Small Refined Spills (<1,000 bbl) have the potential to occur during Exploration activities. Small spills may be contained on a vessel or on a MODU; those spills reaching the water may be contained by booms or absorbant pads.

In the event of small accidental oil spills during exploration, the number of workers employed for cleanup 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 are, how efficiently the cleanup is executed, and how well coordination of the cleanup is executed among numerous responsible entities. In general, however, small oil spills tend to be contained at the initial spill site. Consequently, impacts to the economy from small refined oil spills would have little measurable impact on employment, income, and revenues, and would be considered negligible.

Development

Accidental Oil Spills and Gas Releases

In addition to the small refined spills analyzed under exploration, development activities contribute to the potential for small or large (≥1,000 bbl) oil spills, or gas releases. The economic impacts of small refined spills during development are the same as those analyzed above for exploration.

A potential large oil spill or gas release occurring during development could generate hundreds of direct and indirect jobs (see definitions on next page) and thousands of dollars in personal income associated with oil-spill response and cleanup in the short term. Revenue impacts from large spills would also potentially include property tax revenues accruing to NSB from any additional onshore oil-spill-response infrastructure. Positive revenue impacts on the NSB would be in the form of property tax revenues from any new infrastructure built to house the influx of workers and infrastructure. If the Trans-Alaska Pipeline System (TAPS) throughput 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 affected, as would indirect revenues associated with full pipeline enhanced value from North Slope production. Any other displaced or lost production from Federal OCS or onshore leases would reduce revenues the Federal government receives through oil and gas production. Other exploration and production activities that would generate economic activity through employment, personal income, and revenues could also be affected by potential space/use conflicts or a moratorium that result from a spill. Loss of access from congested shipping routes and crowded ports could have a short term effect on Alaska economic output as delivery of goods and services could be reduced.

Potential negative effects from a hypothetical large oil spill include effects on subsistence hunting and fishing, which could affect the mixed cash/subsistence economy of the NSB. A large oil spill could also displace future economic activity that currently is relatively minor or could potentially exist in the Arctic. A large spill could affect jobs and revenues associated with any potential 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 large oil spill could have similar impacts on jobs and revenues generated by potential tourism, recreation and increased marine shipping activities occurring in the region.

Production

Accidental Oil Spills and Gas Releases

Small or large oil spills or gas releases are possible during oil and gas production activities. Impacts to economy from small or large oil spills or gas releases are analyzed under exploration and development, above.

Impacts of the Scenario through Time

The analysis that follows evaluates the economic impacts of the Scenario over time. Regardless of the phase, small spills and gas releases are expected to generate negligible amounts of employment, income, and revenues, and large spills are expected to generate minimal to moderate employment, income, and revenue. Consequently, this analysis first discusses the impacts of exploration activities on the economy, and then discusses the impacts of development and production activities on the economy. It should be noted that some exploration, development, and production activities would occur concurrently during the 77-year life of the Scenario; these activities would have overlapping effects on the economy. For example, during Years 10-25 of the Scenario, each phase of activities - exploration, development, and production – would occur, causing overlapping impacts on employment, income, and revenue.

Figure 4-2 describes the types of overlapping oil and gas activities that would occur over 77 years as the Scenario unfolds. Effects on employment and income would occur during each of the five time periods depicted in Figure 4-2.

The following definitions apply to the analysis of the economic impacts of the Scenario through time:

- “Direct employment” includes those workers with jobs directly in oil and gas exploration, development, production, and decommissioning
- “Indirect employment” includes those workers in industries that support the direct exploration, development, production, and decommissioning activities. These include jobs in transportation, such as shuttling workers by air between Anchorage and the North Slope. Direct and indirect workers spend a part of their earnings for expenses such as food, housing, clothing, etc.
- “Induced employment” is the aggregate of workers associated with providing goods and services to direct and indirect workers
- “Personal income” refers to compensation to direct, indirect and induced works from employment

Exploration

Exploration activities from the Scenario, including marine-seismic surveys, geohazard and geotechnical surveys, and drilling of exploration/delineation wells, would impact the economy through increased employment, labor income, and potentially, revenues. These activities would require the construction of infrastructure, including the construction of an exploration base, supply boat terminal, air support base, and search and rescue base. Workers would be needed for jobs for the construction and operation of this infrastructure. While some of these jobs would be obtained by local North Slope residents (i.e., local residents working as Protected Species Observers), the vast majority of these jobs would be obtained by non-locals with the technical skills required to conduct the activities. Based on historic patterns in the North Slope oil industry, these workers would not live on the North Slope as discussed in the section below.

In addition to employment and labor income, development of onshore infrastructure to support exploration activities would generate property tax revenues because infrastructure built and operated onshore is subject to property taxes that accrue to the State of Alaska and the North Slope Borough (NSB). However, while onshore infrastructure would be constructed during the exploration phase, property tax revenues would not be accrued until the facilities begin operating (i.e. their “useful life” begins). The useful life of this infrastructure would not begin until the development and production phase. As a result, any property tax revenues and employment generated from those revenues would not be realized until the development and production phases (described in the section below).

Small spills (<1,000 bbl) could occur during exploration activities, and the potential for small spills continues into the Exploration and Development phases. These spills could result from refueling activities during geological and geophysical activities (geohazard, geotechnical or marine seismic surveys), or exploration drilling activities, and are likely to consist of refined oils. The estimated total, as well as the annual number and volume of small refined oil spills during exploration activities are displayed in Tables 4-1 and 4-2.

Because the impacts of exploration on local employment and labor income would be minimal, normal or routine functions of the local community would not be disrupted. Accordingly, the economic effects from this phase of the Scenario would be minor.

Development and Production

Revenue

Several types of revenue streams would result from development and production activities. The State of Alaska would receive revenues from property taxes on onshore oil and gas infrastructure, state corporate income tax, and potentially, royalties from the reduction in the TAPS tariff due to OCS volumes.

Property taxes are assessed against onshore infrastructure. Property tax revenues are at their peak when the highest-value onshore infrastructure is constructed and begins operating. This is likely to occur during the third time period of the Scenario (Figure 4-2, i.e. Years 10-25 of the Scenario). To determine property tax revenues, BOEM estimates that onshore support facilities and pipelines would be valued at approximately $6.6 billion (BOEM 2014 internal estimates using the MAG-PLAN Alaska 2012 update (Burden, Cuyno, and Thistle, 2012). The value of taxable onshore infrastructure is determined using data on capital costs contained in the BOEM MAG-PLAN Alaska 2012 Update economic impact model. The property tax calculation in MAG-PLAN Alaska uses the capital cost of all taxable onshore infrastructure as the basis for estimating local and state property taxes. The State would collect 20 mills (2%) in annual property taxes on that infrastructure, returning 18.5 mills (1.85%) to the NSB. BOEM calculates property tax revenues using straight line depreciation at a rate of 12.5% per year, then extend the useful life of infrastructure based on any remaining reserves. The useful life of onshore infrastructure, and therefore, the property taxes assessed against that infrastructure is extended until all oil and gas reserves from the Scenario are depleted and the infrastructure is no longer in use. This could extend beyond the duration of the 77-year Scenario, as infrastructure built for the purposes of the Proposed Action could still be used by other development projects taking place at the end of the Scenario.

Property tax revenues associated with onshore infrastructure could total approximately $3.3 billion for the NSB. The State could receive a total of about $272 million. Such an increase in property tax revenues would provide opportunities for the NSB to improve the quality of life of its residents by improving or creating schools, economic opportunities, and infrastructure such as housing, transportation, waste storage, access to clean water, and affordable/reliable electricity, among others.

State corporate income taxes (SCIT) are a percent of the value of production. SCIT accrues to the State once oil production begins, peaking when the value of oil production is at its highest. The SCIT is determined by multiplying annual estimates of the value of production (i.e. oil price multiplied by volume of oil produced), by the SCIT rate of .13%. The total SCIT is estimated to be $639.965 million.

Royalties could accrue to the State from a reduction in the TAPS tariff due to oil produced from the Scenario flowing through the pipeline. The TAPS per barrel tariff was $5.93 in 2013. As the volume of oil that flows through TAPS increases, the TAPS tariff decreases. OCS oil that is transported through the TAPS oil pipeline increases throughput; higher throughput reduces the tariff on all the oil that is flowing through the pipeline. Since the price of oil at the wellhead is determined by subtracting the transportation costs from the market price of oil, a lower tariff essentially increases the wellhead value of Chukchi Sea oil. Since the royalty on oil and the production tax are based on the wellhead value of oil, a lower tariff resulting from increased TAPS throughput from Chukchi Sea oil would increase revenues to the State. The revenues accruing to the State as a result of the TAPS tariff reduction would be approximately $2.8 billion.

The Federal Government would receive royalties on oil and gas production from the Scenario at a rate of 12.5% of the value of oil and gas production. The total royalties to the Federal Government would be $89 billion. The State does not currently receive royalties from OCS oil and gas production. The Leased Area of the Proposed Action is beyond the boundary of revenue sharing associated with Section 8(g) of OCSLA, which mandated that 27% of all revenues from production within 3 miles seaward of the Federal-state boundary be given to the appropriate coastal state.

For purposes of this analysis, Lease Sale 193 is assumed to result in the production of 4.3Bbbl of oil over 77 years. This would contribute to extending the useful life of the TAPS, generating millions in revenues for the State.

Shareholders of Alaska Native Regional and Village corporations could also stand to benefit economically from the recent creation of a new company referred to as the Arctic Iñupiat Offshore, LLC (AIO). According to a July 31, 2014, press release, Arctic Slope Regional Corporation (ASRC) and six North Slope Alaska Native Village have joined together to create a new company known as the Arctic Iñupiat Offshore, LLC (AIO). The members of AIO are ASRC, Ukpeaġvik Inupiat Corporation, Tikigaq Corporation, Olgoonik Corporation, Kaktovik Iñupiat Corporation, Atqasuk Corporation and Nunamiut Corporation. Communities represented by these corporations include Barrow, Point Hope, Wainwright, Kaktovik, Atqasuk and Anaktuvuk Pass. The Village Corporations for Point Lay and Nuiqsut were not included in the AIO, but still have the option to become part of the joint venture.

According to the press release, AIO’s primary focus is creating alignment for responsible development within the Arctic Slope region, planning for the future, providing a voice for Arctic Slope Iñupiat with a seat at the development table, and economic stability. Toward that end, AIO and Shell Gulf of Mexico Inc. (Shell) entered into a binding agreement that will allow AIO the option to acquire an interest in Shell’s Chukchi Sea leases and projects on the leases. Under the option agreement, Shell will assign AIO an overriding royalty interest in oil and gas produced from specific leases in the Chukchi Sea. AIO would also have the option to obtain a working interest in leases owned by Shell at the time Shell proceeds with development and production. AIO does not pertain to leases in the Beaufort Sea.

The overriding royalty interest would provide AIO a share of revenues from production, free of all costs. This would guarantee AIO a share of the revenues from production of Chukchi Sea leases held by Shell without incurring any of the risks or costs of that production. If AIO obtains a working interest, it would be obligated to pay a percentage of development and production costs, and would receive a share of the production profits after royalties have been paid. Some of the revenue to AIO from the royalty or working interest would be distributed as dividends to the shareholders of its member Alaska Native corporations.

The AIO represents another potential source of revenue for shareholders who could reside anywhere - in the NSB, the State, or elsewhere. The economic effects from any revenues distributed to shareholders of the AIO member corporations could be widespread. This potential increase in AIO revenues and shareholders' income could create additional jobs and generate other types of income, as AIO invests in projects and shareholders spend some of their dividends from AIO.

Employment and Income

As in the exploration phase, employment and income would be generated during the development and production phases. Construction of necessary infrastructure would occur during these phases, including the construction of pipelines, roads, platforms, pads and wells. Workers would be needed for jobs to construct and operate this infrastructure. As is the case during exploration, some of these jobs would be obtained by local North Slope residents, but most of these would be obtained by non-locals with the necessary technical skills. This pattern of employment is supported by existing data from the oil and gas industry on the North Slope. Most direct workers in this industry historically have worked in enclaves located on the North Slope or on offshore oil platforms and commute to residences elsewhere in the State during their time off. Historically, approximately 30% of North Slope workers in this industry have commuted to locations outside Alaska (ADOLWD, 2014a).

Based on this historic pattern, BOEM anticipates that most direct workers during the development and production phases of the Scenario would live in enclaves either on- or offshore approximately half of the days in any year (following a typical work schedule of two week on/two weeks off). In these enclaves, most of the workers live in a self-contained environment where most of their needs, such as lodging and food, are provided. BOEM also anticipates that most of these workers would live outside the North Slope, with some living outside Alaska. The economic impacts from this pattern of direct employment would be manifested outside the North Slope, as most of the income available to these workers would not be spent locally.

However, BOEM anticipates that local employment would increase substantially as a result of development and production from the Scenario due to a number of factors. A major factor is the increase in revenue that would accrue to the NSB from development and production under the Scenario. Currently, the NSB government is the largest employer of NSB resident in the region. NSB gets most of its tax revenue to fund government operations from property taxes from onshore oil and gas infrastructure. In 2012, for example, NSB received $322 million, and $43,959 per capita, in revenues from oil and gas property taxes (ADCCED). Because development and production from the Scenario would substantially increase property taxes, the NSB would receive more revenues to provide even more jobs to NSB residents, who in turn, would spend a portion of their income locally.

Estimates of direct and indirect employment and personal income effects from the 77-year life of the Scenario are shown below in Table 4-52. These estimates are derived using the MAG-PLAN Alaska economic impact model. MAG-PLAN Alaska is a regional economic impact model used by BOEM to generate estimates of potential economic effects of OCS development in Alaska. The activities described in the Scenario drive the model. MAG-PLAN Alaska uses a 2 stage process: 1) Using a specific Scenario of exploration, development, and production activities as inputs, Stage 1 generates estimates of direct employment, direct industry spending on labor and non-labor components, and government revenues; 2) Stage 2 of MAG-PLAN Alaska then uses adjusted IMPLAN multipliers to estimate indirect and induced effects of industry spending, labor income spending, and government spending in a particular region. MAG-PLAN Alaska estimates the number of "job years" that the activities described in the Scenario would create over 77 years. A "job year" simply represents one job for one year. For example, 10 "job years" can represent a job created for a single person for 10 years, jobs created for 10 workers for one year each, or any combination thereof. The term "local" in Table 4-52 refers to residents of the NSB, and "other Alaska" refers to residents of Alaska who live outside the NSB. These estimates reflect our best professional judgment, using the best available information and methodology available at the time of this writing, and are not intended to be firm predictions.

Table 4-52. Employment and Income Effects from the 77-Year Scenario.

	Employment (Number of Job Years)						
	Direct		Indirect and Induced		Total for Alaska	Direct Jobs	
	Local	Other Alaska	Local	Other Alaska		Other U.S.	Total U.S.
Annual Average:	210	5,576	1,379	8,046	15,211	6,597	12,383
Peak Employment:	422	10,082	1,789	16,008	25,798	12,017	21,590
Peak Year:	2043	2040	2022	2019	2043	2035	2035
	Personal Income (Millions of 2013 dollars)						
	Direct		Indirect and Induced		Total for Alaska	Direct Labor Income	
	Local	Other Alaska	Local	Other Alaska		Other U.S.	Total U.S.
Annual Average:	7	349	115	431	902	400	756
Peak Employment:	17	624	150	846	1,517	724	1,360
Peak Year:	2043	2040	2022	2019	2040	2040	2040

Source: BOEM internal estimates using MAG-PLAN Alaska.

As shown above in Table 4-52, oil and gas development and production from the Scenario would have a positive impact on employment and income in the region. A large development project of this nature in a frontier region like the Chukchi Sea, with extreme environmental and logistical challenges, would entail substantial investment, infrastructure, and manpower, yielding employment and income. The NSB could receive an annual average of about 1,600 total job years, with the State receiving an annual average of approximately 15,200 job years. These jobs, many of which are high wage oil and gas related jobs, could generate about $42 billion in total income for the State, with an annual average of $780 million, and over $5 billion in total income for the NSB with an annual average of $122 million. Peak direct local employment is estimated to be 422 job years and occur in Year 43, with peak indirect and induced local employment of 1,789 job years occurring in Year 22. Large values for employment and associated income are to be expected given the number, scale, and duration of activities during exploration, development, and production of 4.3 Bbbl of oil and 2.2 TCF of natural gas over the 77-year timeframe described by the Scenario.

Table 4-52 includes estimates of employment and income associated with the development and production of natural gas, in addition to oil. Natural gas development would initially cause a relatively small increase in employment and income, as additional workers would be needed to modify, expand, and develop new infrastructure. The employment and income associated with developing gas would be less than that for oil development, because the infrastructure needed for gas development and production (roads, facilities, etc.) would have already been built.

Increased employment and income would occur throughout each phase of the Scenario. Employment and income would begin to rapidly increase during the exploration phase as marine seismic surveys, geohazard and geotechnical surveys are conducted and drilling of exploration/delineation wells begins. Employment and income would then peak during the development phase as construction of offshore and onshore infrastructure ramps up and oil production begins; drop to a plateau during production; and continue to drop as oil production declines until decommissioning takes place.

Increased employment and income could result in increased population. This could lead to an increased demand for public services and infrastructure in the NSB, including housing, water, waste disposal and storage, electricity, telecommunications, port/dock access, roads, and airstrips to accommodate increased air traffic from larger planes, among others. Population increases could also lead to future demographic changes as the region experiences an influx of outside cultures. This effect would likely be offset in part by the nature of enclave development.

Increased population and a corresponding demand for infrastructure and public services could lead to boom and bust cycles. The development of Prudhoe Bay and the TAPS caused wide fluctuations in the population of the NSB and the State of Alaska and increased the demand for services and infrastructure to accommodate in the rising population. Population growth during the 1970s and early 1980s was driven primarily by two converging factors: high oil prices and increases in the birth rate from those who settled in Alaska during the initial boom. As the activities described in the Scenario wind down, NSB and the State could experience a net migration loss, leaving under-utilized or unused public services and infrastructure behind.

Boom and bust cycles could also lead to local economies overheating from inflation caused by rapidly increasing wage growth and increasing prices in the NSB and State. Average wages increases in the local economy can lead to increasing prices of goods and services, as businesses have to raise their prices in order to pay their employees higher wages. It is possible that increased employment could also have a negative impact on the participation of local residents in subsistence hunts, as some local residents who would otherwise engage in subsistence activities may instead pursue high-paying oil and gas jobs.

Conclusion

Considering all time periods from Years 1-77, the economic impacts from the routine oil and gas activities proposed in the Scenario would result in substantial positive economic impacts. As Table 4-52 illustrates, there would be long-lasting sweeping changes in local employment and labor income. As a result, the impacts on the economy from the Scenario would be major. In the event of a large oil spill, overall economic effects would continue to be major.

4.3.10.2. Alternative II – No Action

Under this alternative, the economic benefits, including employment, income, and revenues at the local, State, and Federal level, would be delayed or lost.

4.3.10.3. Alternative III – Corridor I Deferral

Alternative III provides the largest deferral area of the action alternatives – a corridor approximately 60 miles (97 km) wide along the Chukchi Sea shoreline. If Alternative III were selected, the distance from the shore to many activities could be greater than under Alternatives I and IV. No exploration or development drilling or platform construction would occur within the corridor, although certain activities (i.e., installation of a pipeline extending from the leases outside the corridor to the shore) could occur there. Of the Lease Sale 193 leases, only five are within Corridor I.

The minimum distance from shore under Alternative III could be slightly greater for the following than under the other action alternatives: length of pipeline from a platform to shore; travel distances from vessels and aircraft; source of discharges, emissions and noise from drilling and platforms; and, potentially the source of a large OCS oil spill.

The economic impacts of Alternative III are largely the same as for the other action alternatives. Using the Impacts Scale in Section 4.2, the level of impacts under Alternative III would be consistent with the other action alternatives.

4.3.11. Subsistence-Harvest Patterns

As described in Chapter 3, subsistence is fundamental to Alaska Native communities, providing not only important food resources, but also forming the basis for core community values and cultural identity. Effects on subsistence harvests might lead to changes in sociocultural systems and community health, and can also be an issue with respect to Environmental Justice (EJ). Sociocultural systems, community health, and EJ are discussed individually in subsequent sections. For the convenience of the reader, this section generally summarizes key impacts to species used for subsistence. However, more detailed and technical analysis of these impacts is contained in sections 4.3.4 through 4.3.8, the biological sections that describe effects on various species, including birds, mammals, fish, and lower trophic organisms.

4.3.11.1. Alternatives I and IV

Even though existing leases are, at a minimum, 60 mi offshore of Wainwright, the Scenario has the potential to affect subsistence use through diminished availability of subsistence resources for harvest.

The closest leases issued through Lease Sale 193 are 60 miles from shore. It is unlikely that the leases will present a direct conflict with subsistence activities; however, many Scenario activities still have the potential to impact marine subsistence hunts because they are planned on land or in waters used by hunters of subsistence resources, particularly those in Wainwright, Atqusak, Nuiqsut, and other nearby communities. A recent study documented that marine subsistence use routinely occurs up to 30 miles offshore of Wainwright with high frequency (Figures 4-13 through 4-16, SRB&A, 2013a). Scenario activities that have the potential to affect species availability and subsistence harvests include OCS seismic, geotechnical and geohazard surveys, OCS exploration and production drilling, support and processing shore-base facilities, offshore and onshore pipelines, air and sea vessel support traffic, onshore gravel mine sites, and new roads. It is important to bear in mind that most subsistence resources are migratory and only available on a seasonal basis. Thus, it is critical to analyze timing and location of Scenario activities as related to the timing and location of subsistence resource harvesting practices.

For this analysis, communities closest to the Leased Area - Barrow, Wainwright, Point Lay, Point Hope, Atqasuk, and Nuiqsut – are the primary focus. However, all regions and communities, including those in the Northwest Arctic Borough (NWAB), Bering Strait region, and the Russian Chukotka region, are included in the analysis; all participate in subsistence harvesting in the marine environment, and all may face a higher potential of impacts from the effects of a large oil spill or concerns about contamination.

4.3.11.1.1. Impact Producing Factors

This section identifies IPFs associated with the Scenario that have the potential to affect subsistence-harvest patterns. Each IPF is organized by phase of oil and gas activity (i.e. exploration, development, production, and decommissioning). IPFs which occur during multiple phases are addressed in the phase in which they first appear and are then referenced where applicable. The primary categories of IPFs affecting subsistence are noise, physical presence, discharges, habitat alteration, and accidental oil spills. For each phase below, particular activities leading to these IPFs are first described, and then the ways in which the activities produce impacts on subsistence-harvest patterns are explained.

Accidental spills, though not considered routine oil and gas activities, have the potential to occur during each phase of the Scenario. General impacts of small and large spills are addressed as IPFs in the subsection where they have the potential to occur. The impacts of spills within the larger context of all other activities that occur during each period are analyzed below in the “Impacts of the Scenario through Time.”

Exploration

The activities associated with the exploration phase have the potential to impact subsistence-harvest patterns are vessel-based marine surveys, vessel and aircraft support, exploration and delineation well drilling, Mobile Offshore Drilling Unit (MODU) placement, and shore-base construction.

Noise

Noise produced both underwater and above water has the potential to impact marine and terrestrial subsistence resources. Noise from the following exploration activities can result in impacts:

- Airguns and Sonar equipment
- Vessel speed, engines and onboard equipment, propellers, cavitation (aeration of the water), ice management
- Aircraft, engines, propellers, main rotors, and tail rotors
- MODUs, on-board machinery
- Construction vehicles and equipment (on and offshore)

Noise can disturb subsistence species including bowhead and beluga whales, seals, walrus, other marine mammals; fish, birds, caribou, and other terrestrial mammals. Noise can be an underwater disturbance as a result of seismic activities or vessel engines, and also an above water disturbance as a result of engines from vessels and aircraft. Communities that rely on the marine environment for food and cultural identity, along with subsistence hunters who provide for the larger community have expressed concerns that anthropogenic sound from industrial activities negatively affects both subsistence animals and hunting success. Alaska Native whalers have expressed concerns that vessel traffic noise associated with oil and gas activities may cause bowhead whales to deflect or even migrate farther offshore in the spring, becoming less accessible to subsistence hunters over time (Greene, 2003). Schweitzer (2013) states that noise from oil drilling is an issue of concern among Alaska Native residents of the Arctic, who believe that industrial noise disturbs animals used for subsistence, scaring them away. Galganaitis (2014) noted that Nuiqsut whalers observed that vessel traffic noise made bowhead whales skittish and difficult to approach.

Marine Vessel Surveys

Vessels used to conduct vessel-based marine surveys produce noise from airguns and sonar equipment, engines, and cavitation; as well as from ice management (Moore et al., 2012).

Airgun and Sonar Noise

Seismic operations typically consist of a vessel that tows airgun arrays and receiver cable streamers. Airguns produce lower frequency noise in pulses by discharging high-pressure air into water. When used in seismic surveys, towed behind the seismic vessel in an array, air guns are fired at 10-15 second intervals depending on the vessel speed and size of the airgun. Most of this noise is focused downward and then radiates horizontally. Noise from the airguns quickly attenuates in the ocean. Fish (Section 4.3.5), marine and coastal birds (Section 4.3.6), and marine mammals (Section 4.3.7) can be sensitive to noise and seismic disturbance if they are in the vicinity of discharging airguns or if their exposure is long-term. When exposed to underwater noise, fish and marine mammals may exhibit avoidance behaviors. If these resources and their patterns are altered due to noise, traditional subsistence harvests could be affected, though sonar noise occurs in higher frequencies that can exceed the hearing capability of marine mammals. Depending on the subsistence species, sonar sounds should not cause avoidance behaviors or physiological effects in marine mammals (see section 4.3.7). Operators and potentially affected subsistence harvesters will normally coordinate to develop an agreement for ways to mitigate impacts to subsistence hunts.

Vessels and Aircraft Support

Vessel noise. Types of vessels and noise sources include:

Small vessels and boats. Small vessels may be used for support during drilling operations for crew transport, equipment transport, and for studies related to monitoring and mitigation.

Large vessels. These vessels are characterized by their powerful engines driving mostly multiple, slow turning propellers (screw propulsion) which produce low-frequency sounds. Radiated noise from these vessels is usually based on several variables including vessel and engine size, speed, and deadweight cargo capacity (cargo load).

Icebreakers. Some oil and gas activities in the Chukchi Sea require icebreaker support. Noise generated from icebreakers tends to be louder and more variable than similar vessels. According to Richardson et al. (1995), the greatest underwater sound during icebreaking operations is produced by cavitation of the propellers as opposed to the engines. Noise is produced by the pushing of ice, which radiates noise levels higher than what these vessels produce in open water.

Vessels and their operations create noise impacting subsistence-harvest patterns from the following sources:

- Vessel traffic numbers and speeds
- Operating noise from engines and on-board equipment
- Cavitation noise - the aeration (bubbling) and boiling effect of water caused by creation of a low pressure area, from pumps and propellers
- Ice management noise

Fish, birds, and marine mammals may be exposed to vessels when seasonal migration or spawning patterns overlap in time and space with the proposed vessel activities on the Leased Area and adjacent areas. Most vessel operations occur in the open-water season and in-ice, as stated previously, providing primary support as seismic survey vessels, crew transfer and supply support vessels, re-fueling support, construction support, placement of drilling platform facilities, and icebreaking or ice management.

Conclusion

Vessel noise may cause disturbance to fish, marine and coastal birds, and depending on a variety of variables, to marine mammals. This could result in avoidance or deflection from traditional hunting areas and decreased hunting success. Beluga seem to be particularly sensitive to anthropogenic noise (Huntington et al., 1999; Morseth, 1997; Mymrim et al. 1999). This is of particular concern because this species migrates from offshore of Point Lay north in late June through mid-July along the eastern Chukchi Sea coast, near the barrier islands that mark the western edge of Kasegluk Lagoon, on their way northeast past Wainwright to summer in the deep off the Continental Shelf (4.3.7). They are actively sought by the coastal Iñupiaq of the North Slope, and Point Lay is renowned for their beluga hunts. Beluga hunts have the potential to be impacted by aircraft in Barrow and Wainwright. Most vessels would originate from Barrow or Wainwright, and the beluga hunt could overlap temporally with industrial activities. A mitigation measure that subsistence hunters would like to see implemented would be to suspend OCS activities until after the beluga hunts at Point Lay and Wainwright, or July 15, whichever comes first.

Other marine subsistence efforts could also be affected, particularly at Wainwright, including harvesting seals, walrus, sea ducks, and caribou, the latter of which are preferably hunted by boat as they graze on the shore.

The vessels related to seismic surveys generally operate in open-water season (July-October) and early winter periods (October-December) before freeze-up (Lefevre, 2013).

Aircraft noise

Types of aircraft and noise sources include:

- **Helicopters.** Helicopters may be used for support during drilling operations for crew transport, equipment transport, and for marine mammal mitigation. Noise generated from helicopters has many frequencies due to main rotor noise, tail rotor noise, airframe noise, and engine noise (Leishman, 2006). Ringed and spotted seal, used for subsistence, have exhibited noticeable reactions to helicopters (Born et al., 1999). Ringed and spotted seal hunts have the potential to be interrupted in Barrow or Wainwright since most flights would originate from these communities during the harvest periods of June through August, when the majority of exploration activities would occur.
- **Fixed-wing Aircraft.** Fixed-wing aircraft are typically used when assessing marine mammals before, during, and after seismic surveys and drilling operations. Aircraft noise generated by fixed wing aircraft is usually due to engine noise (from moving engine parts and air being expelled at high speed once it passes through the engine). Fixed-wing aircraft will be used to transfer crews to and from the Arctic, and likely will be used to bring mail and supplies to the shorebase/production base.

  Noise from aircraft can affect birds, marine mammals, and terrestrial mammals used for subsistence. Subsistence resources such as eiders and loons could react to the airborne sounds of planes and helicopters; most birds are well aware of helicopters and planes and react/move away from the aircraft noise before the aircraft itself can harm them. Marine mammals, utilized for subsistence, can be affected by aircraft noise since it can be audible even underwater from the aircraft passing overhead (Greene, 1995). For marine mammals, helicopter noise is generally audible for only tens of seconds, and responses have varied due to flight altitude and sound levels (Richardson and Malme, 1993). Bowhead whales have shown reactions to helicopter noise ranging from little to no response through avoidance behaviors (Herman, 1980), though beluga whales have been observed sounding when a fixed wing aircraft flew overhead (Morseth, 1997; Patenaude et al., 2002). Onshore, caribou and other terrestrial mammals used for subsistence often respond to aircraft noise with a higher sense of alertness and may exhibit a flight response. Caribou flight responses could result in separation from young, injuries, or energetic losses. Muskoxen exhibit the same responses as caribou. As they have lower population numbers than caribou, these effects could have a detrimental effect on subsistence if the population decreased significantly. Bears, wolves, and wolverines also exhibit a startle and flight response.

Drilling Noise

Types of drilling equipment and noise sources include:

Drilling Units. Noise generated by MODUs may be caused by generators, drilling machinery, and the rig itself. Drilling noise during exploration can come from various types of MODUs which are either self-propelled or towed from one site to another at speeds below 10 knots. MODUs generate continuous underwater noise from the MODU itself, and from the use of generators and drilling machinery on board. This noise can disturb marine mammals and other subsistence species, resulting in avoidance or deflection. If a MODU is drilling during the subsistence hunting season, this means that sound propagates through air and into structures rather than directly into the oceans (Richardson, 1995).

Construction

Construction and noise sources may include:

Blasting. Offshore blasting may be conducted to facilitate construction of the shorebase, supply boat terminal, or pipeline construction. Noise generated during blasting operations may be from air pressure waves generated by the explosion, causing a startle effect, deflection, or avoidance by subsistence species. (Schexnayder, 1999).

Trenching. Trenching and placement of pipelines will occur somewhere offshore of Wainwright between Icy Cape and Point Belcher. According to the Scenario, trenching will occur during the open water season. This is also the period when marine subsistence hunting is most intense. The intensity of subsistence effort over a three season period can be viewed on Figure 4-13 (SRB&A, et al., 2013a). Both Point Belcher and Icy Cape are identified on this map. As can be seen, pipeline trenching will inevitably conflict with marine subsistence harvest efforts during the open-water season.

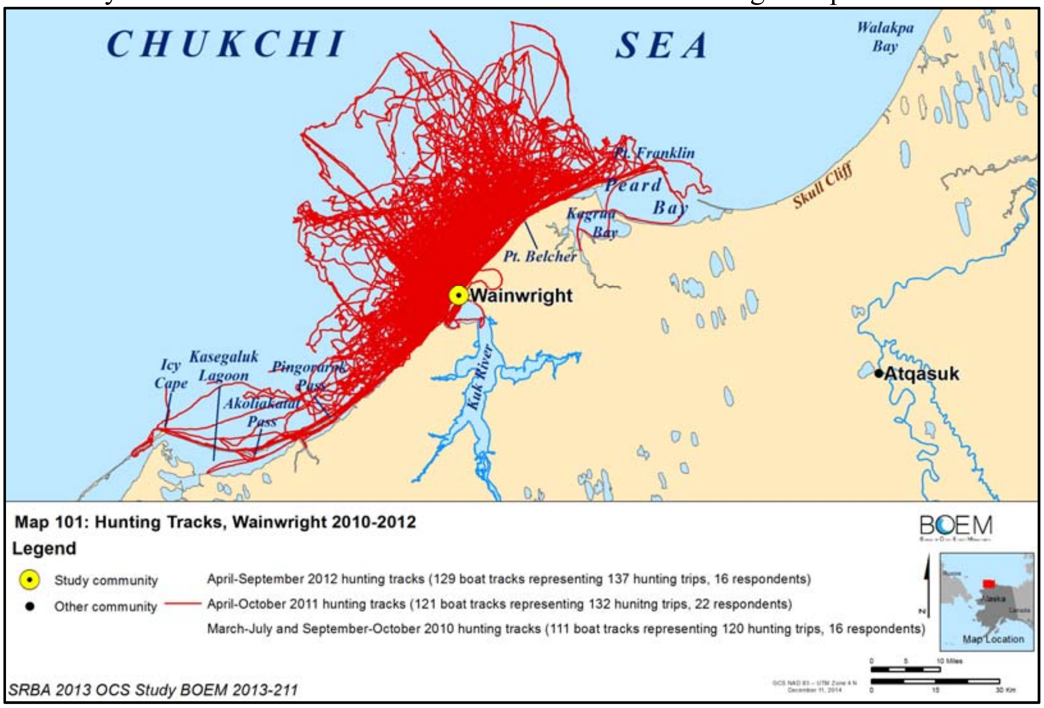


Figure 4-13. Wainwright Subsistence Hunting Tracks for 2010-2012.

Equipment. Onshore construction equipment can be stationary or mobile. Stationary equipment consists of generators, pumps, compressors, and jackhammers producing variable and sporadic noise that is of short duration, abrupt onset, and high intensity with a rapid decline. Mobile equipment such as dozers, graders, crew vehicles, etc. create noise in a cyclic fashion and can be relocated if necessary.

Construction noise during exploration can come from various types of equipment both on and offshore. Offshore, noise from these activities has the capacity to directly cause disturbance to subsistence species such as fish, birds, whales, seals, walrus and other marine mammals. These effects can have consequences for subsistence-harvest patterns such as avoidance of traditional migration pathways or hunting areas. Construction of platforms and offshore pipelines generates underwater noise from the use of generators and machinery on board platforms.

Onshore, construction equipment noise associated with the shorebase can be caused by equipment and vehicles. Caribou would mostly avoid moving vehicles whenever possible unless large movements or migrations of those animals are underway. Muskoxen also avoid moving vehicles or heavy equipment operations (See Section 4.3.8).

Physical Presence

Physical presence can come from man-made structures or as a consequence of human interaction in a remote location such as the NSB. Physical presence both on and offshore during exploration can disturb subsistence species or cause injury. These subsistence resources include bowhead and beluga whales, seals, walrus, other marine mammals, fish, birds, caribou, and other terrestrial mammals. Communities that rely on marine mammals for food and cultural identity may realize a decrease in subsistence resources and hunts if the physical presence of oil and gas activities affects both subsistence animals and hunting success. The potential effects on those species include behavioral changes resulting from the physical presence of vessels, aircraft and field crews during the exploration phase.

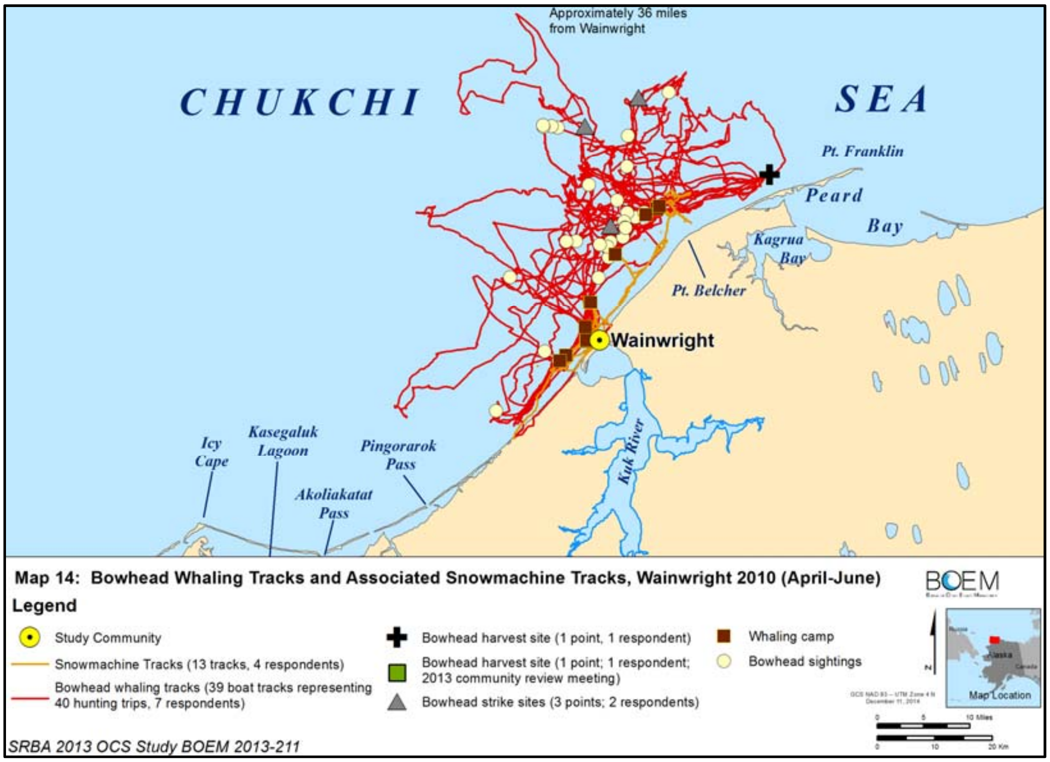


Figure 4-14. 2010 Wainwright Bowhead Whaling Tracks.

The Wainwright spring bowhead whale hunt may occur in any month from February through early June—depending on sea ice conditions, the timing of the bowhead whale migration, and presence or absence of leads. A review of maps that display bowhead hunting camps on the sea ice offshore of Wainwright and hunters' tracks over three seasons indicates usage of the sea ice offshore of Point Belcher, extending about 40 miles paralleling the coast, ranging as far north as midway on the spit that terminates at Point Franklin, and as far south as nearing Pingoraruk Pass (Figures 4-13, 4-14, and 4-15) (SRB&A, 2013a). In two of the three seasons, a whaling camp was established on the sea ice immediately in off Point Belcher, about half of a mile from shore. The other camps, on the ice at the edge of the lead or leads, range from about one-half of a mile to two or three miles from the shore.

There may be enough of a spatial distance to buffer the physical effects of industrial development, but to achieve maximum mitigation of impacts, industry would need to coordinate closely with the community each season to ensure that transportation or construction noise would not interfere with the whaling effort.

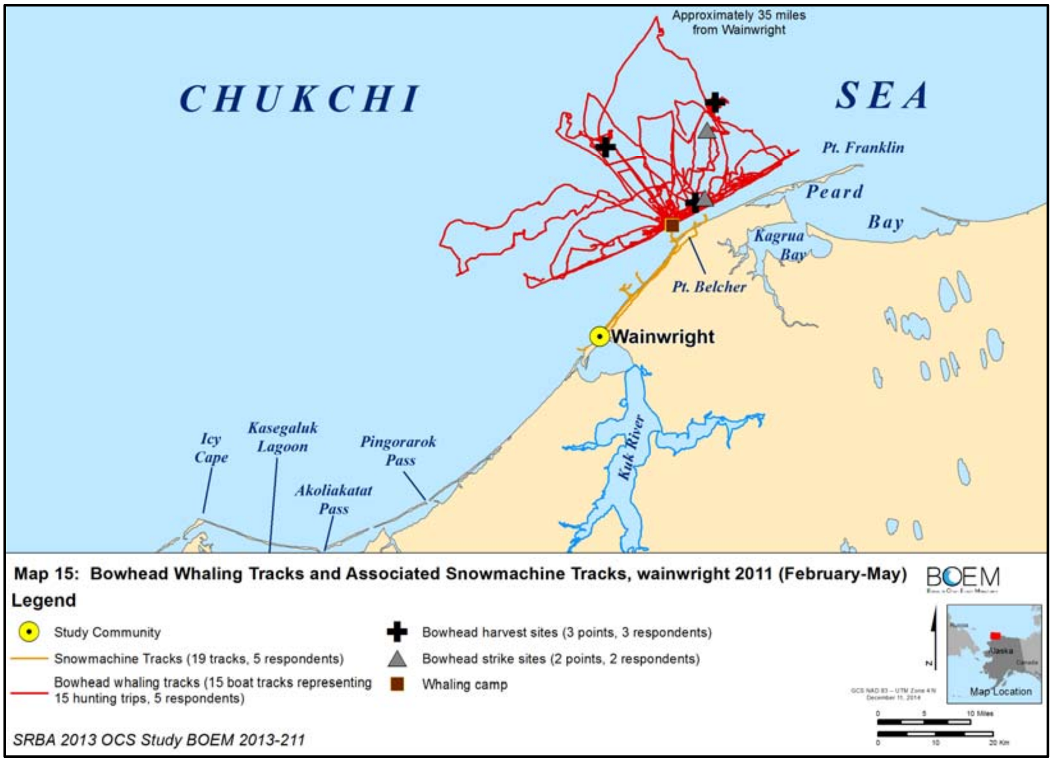


Figure 4-15. 2011 Wainwright Bowhead Whaling Tracks.

Mitigation measures are discussed in the Impacts of the Scenario through Time section, but it should be noted that anthropogenic noise from a shorebase between Icy Cape and Point Belcher would be the greatest concern. Any traffic to the Leased Area could create noise impacts.

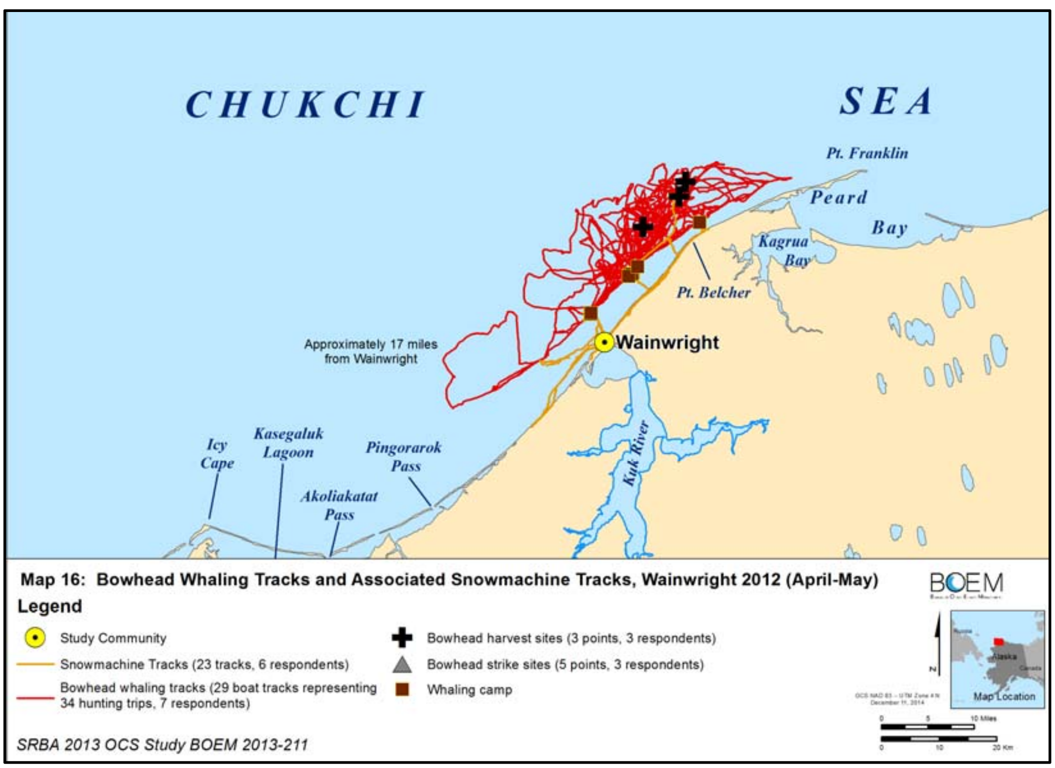


Figure 4-16. 2012 Wainwright Bowhead Whaling Tracks.

Vessels

As identified in the vessel noise section above, there are various types of vessels utilized during this phase. Noise and mere presence transiting to and from the Leased Area could be a source of disturbance to subsistence efforts in the marine environment. Wainwright marine hunting efforts during three documented open-water seasons extended offshore over 40 miles, as far east as Peard Bay, and as far south as rounding Icy Cape, with the highest density of usage occurring from the coastline to about 30 miles offshore.

The effects of increased vessel presence on marine mammals could be experienced most often from July to November—open water marine subsistence-harvest months that are critical for subsistence communities like Wainwright as described in the opening paragraph above. If vessel traffic and presence increases during these months, there is a potential for subsistence resources to deflect from the coastline or avoid the area altogether. If deflection or avoidance occurs, it could impede subsistence hunts. This presence could not only limit the availability of resources, but also restrict access to hunting areas or reduce hunter success due to deflection of resources, causing hunters to travel farther from traditional hunting areas. This could cause hunts to become more difficult and costly, since hunters would travel farther to obtain resources. For more information about direct effects on specific subsistence resources see Sections 4.3.1, 4.3.5, 4.3.6, 4.3.7, and 4.3.8.

Aircraft

As identified in the aircraft noise section above, helicopters and fixed-wing aircraft would be utilized during this phase; noise and mere presence while transiting to and from the Leased Area would cause them to be a source of disturbance.

Increasing aircraft traffic would have the potential to affect birds, marine mammals, and terrestrial mammals. Nesting birds may be disturbed repeatedly by low-flying aircraft, especially helicopters. When a disturbance occurs, birds may abandon their nests and the eggs or young birds could die or be eaten by predators, reducing both the bird population and eggs available for subsistence harvest. The presence of aircraft could affect marine mammals by startling them; flight paths and the frequency of flights can affect whales, especially belugas, as described in the previous section. Harvests of ringed, spotted, and bearded seals, walrus, and polar bears—all subsistence resources—could be affected. For flights occurring in winter, polar bear subsistence hunts in Point Lay and seal hunts in Barrow could be affected. In the spring, hunts for bowhead whale, beluga whale, bearded seal, and walrus could be affected in Barrow and Wainwright.

Field Crews and Oil Workers

An increase in the presence of field crews and oil workers who could conduct land-based operations has the potential to effect birds and land mammals. Disturbances by field crews and oil workers could occur due to walking in unknown nesting areas, driving equipment or vehicles into nesting areas, and mere presence of anthropogenic noise and human activity.

Onshore, the presence of camps can affect terrestrial mammals. These mammals are inquisitive and do not typically avoid buildings or facilities unless some sort of activity occurs at the site. Effects from human activity could include pedestrian traffic and increasing vehicle traffic due to construction. Much of this physical presence would be high during onshore surveys and even higher during shorebase and production base construction. This construction is anticipated to occur during the exploration phase and potentially continue to increase through the development and production phases, due to onshore pipeline construction and ongoing pipeline maintenance. The presence of field crews and oil workers could impact subsistence hunts by causing terrestrial resources to avoid migration pathways of habitat use areas. Onshore activities and infrastructure could block traditional hunting areas as well, thus limiting hunting access.

Discharges

There are several types of discharges that can occur during exploration. Discharges from exploration operations in the Chukchi Sea are permitted under NPDES General Permits that are issued by the EPA as long as there is no unreasonable degradation of the marine environment. Discharges under a General Permit for exploration typically include sanitary waste, domestic waste, drilling fluids, drilling cuttings, and deck drainage.

Sources and discharge released during exploration can be due to:

- Discharge of water-based drilling muds and drill cuttings
- Discharges of graywater from galleys, bathrooms, and other on-board crew use areas from vessels and platforms.

Muds, Cuttings, Graywater and Ballast Water

EPA has made the determinations that the discharges authorized by the NPDES permits, with the effluent limits, restrictions, and requirements imposed by the permits, would not result in contamination of resources, although there is a perception among subsistence hunters that discharges could affect subsistence resources that would migrate through the Leased Area. Vessels or platform operations on the Leased Area could include discharges of drilling fluids, drilling cuttings, deck drainage, ballast water, and graywater. The Chukchi Sea exploration NPDES general permit AKG-28-8100 (EPA, 2012e) authorizes discharges from oil and gas exploration facilities.

For subsistence users, perceptions of contamination have been an ongoing concern. Iñupiaq traditional knowledge (TK) has long held that bowhead whales have the capacity to smell, are sensitive to odors uncharacteristic to their marine environment, and will deflect to avoid the source of the smell. That bowhead whales indeed have the capacity to smell has recently been substantiated by Western science. Examination of the bowhead whale brain identified olfactory bulbs that connect the lining of the nasal passages, near the blowhole, with the back of the bowhead whale’s brain (Thewissen, 2011). The sensitivity that bowheads have toward different odors was the source of discussion in many North Slope communities during past BOEM public hearings (BOEM SEIS Vol. II, 2011).

In 2012, Shell, working with the Alaska Eskimo Whaling Association (AEWC) agreed to a zero discharge policy in the Beaufort Sea, keeping muds and cuttings contained instead of discharging them into the ocean (USDOI, 2013a). This is a potential mitigation measure which could be utilized in the Chukchi Sea.

Habitat Alteration

Habitat alterations occur when the specific environment of a resource is altered or affects subsistence-harvest patterns. Habitat alterations offshore result from the placement of hard structures in the sea and the disruption of bottom substrates during the pipeline placement, or seismic nodes or anchors dragged on the sea bed. Structures such as platforms, subsea connectors, or exposed pipelines can alter habitats offshore. During the exploration phase, habitat alterations can occur during construction of the shorebase, production base, and supply boat terminal.

Nearshore or coastal lagoon fish utilized for subsistence could be injured or killed by oil and gas activities and lost to subsistence users. During exploration, construction of the shorebase, supply boat terminal, and any expansion of an air support base the onshore landscape could be altered, affecting marine and terrestrial mammals used for subsistence. Habitat alterations during construction can include onshore riparian changes due to excavation of soils and gravel or the road construction. These changes in habitat could change the availability of the resource, if it were to become displaced due to these alterations. For discussions of these effects, see Sections 4.3.4, 4.3.5, and 4.3.9.

Accidental Oil Spills

Small Refined Spills (<1,000 bbl), although accidental, are generally routine, expected, and have the potential to occur during exploration activities. Small spills may be contained on a vessel or MODU, or those spills reaching the water may be contained by booms or absorbent pads. Small refined spills can occur from:

- Vessels
- Leaking connections
- Ruptured lines and seal failures
- Human error while refueling

Small refined spills are primarily aviation fuel, diesel fuel, engine lube, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil. In water, ambient hydrocarbon concentrations of small refined spills would persist for a shorter time than crude oil spill of the same volume. The impacts to subsistence-harvest resource (marine mammals, fish, birds, and terrestrial mammals) and practices from small refined oil spills may include:

- **Marine mammals** can be affected if the small refined spill reaches the water, depending on location, timing, and duration of a small spill, Concerns related to subsistence hunting would be related to small spills occurring during the spring where bowhead whales migrate, resulting in contact with polynyas (open leads) (Section 4.3.7).
- **Fish** would be affected if a small refined spill occurred during beach spawning events. Salmon, an important subsistence resource, particularly for the NWAB, could sustain effects if a small spill occurred near salmon habitats. Other important subsistence fish that would be most affected if a small spill occurred in a very localized area include: Salmon, Arctic cod, saffron cod, Arctic char, pink salmon, chum salmon, rainbow smelt, least cisco, Bering cisco, broad whitefish, humpback whitefish, and dolly varden (Section 4.3.5).
- **Impacts to birds** from small refined spills may include fouling of feathers, ingestion, and skin irritation. Should a fuel spill occur during refueling, a small number of birds in the immediate vicinity of the vessel could be affected, depending on current and wind patterns (for discussions of these impacts, see Section 4.3.6).
- **Terrestrial subsistence resources** could be affected by onshore construction activities during exploration due to contamination of surface water and vegetation utilized for food (for discussions of these impacts, see Section 4.3.8).

During exploration, a refueling barge may be anchored in Goodhope Bay, Kotzebue Sound, and small spills of 50 bbl or less could occur. There is a potential for a fuel spill during fuel transfers between vessels, and a fuel spill would potentially introduce hydrocarbons to the water; this spill would be short-lived due to volatilization of light hydrocarbons but could still potentially affect fish and marine mammals used for subsistence.

Development

Development is the construction of facilities to produce hydrocarbons and move them to market. Many of the same IPFs that could arise from development activities were described for the exploration phase and those potential impacts are not repeated here. Only IPFs stemming from development activities are described below. New activities which can affect subsistence-harvest resources during this phase include:

- Installation of OCS production platforms
- Installation of offshore and onshore oil and gas pipelines

The impacts associated with development activities include: Noise, Physical Presence, Discharges, Habitat Alteration, and Accidental Oil Spills.

Noise

The installation of OCS platforms and onshore oil pipelines are the only new activities generating noise for this phase. The potential effect of noise from drilling wells for oil and gas production would be similar to that previously described for drilling exploration wells. New construction noise in this phase could come from:

- Platform construction
- Pile Driving

Trenching and placement of pipelines will occur somewhere offshore of Wainwright between Icy Cape and Point Belcher. According to the Scenario, trenching will occur during the open-water season. This is also the period when marine subsistence hunting is most intense. The intensity of subsistence effort over a three season period can be viewed on Figure 4.13 (SRB&A et al., 2013a). Both Point Belcher and Icy Cape are identified on this map. As can be seen, pipeline trenching will inevitably conflict with marine subsistence harvest efforts during the open-water season.

Direct impacts to fish and birds used for subsistence resources would be similar to those impacts described in exploration and in Sections 4.3.5 and 4.3.6. Marine and terrestrial mammals utilized for subsistence would likely respond to noise behaviorally through avoidance or skittishness. For more information about impacts on these subsistence resources, see Sections 4.3.7 and 4.3.8).

Of even greater concern, the Scenario calls for installation of pipelines during the open-water season, the period of greatest intensity of marine subsistence harvest efforts. As stated previously, anthropogenic noise could cause marine mammals to deflect or remove themselves from the area or become more skittish and difficult to harvest. The SRBA (2013a) maps 4.13-4.16 illustrate potential temporal and spatial conflicts between pipeline installation and subsistence use; the Scenario states that pipelines will come ashore somewhere between Icy Cape and Point Belcher.

Physical Presence

The installation of platforms and offshore pipelines would increase the number of vessels/barges operating in the marine environment, especially the nearshore environment. These vessels would be anticipated to have similar effects as regular support vessels, but the presence of cranes or larger superstructures could increase the bird encounter rate. Effects of physical presence on fish and marine and terrestrial mammals would be similar to those in the exploration phase (for more information, see Sections 4.3.4, 4.3.5, 4.3.6, 4.3.7 and 4.3.8).

Discharges

The installation of platforms and pipelines would increase the number of vessels/barges operating in the marine environment. Discharges of graywater and ballast water from these vessels would remain regulated by the same EPA NPDES permit, previously described under the exploration phase (for more information, see Sections 4.3.4, 4.3.5, 4.3.6, 4.3.7 and 4.3.8).

Habitat Alteration

The installation of platforms and pipelines would increase the amount of habitat disturbance or modification in the marine and terrestrial environments. Installation of undersea pipelines likely would involve trenching/seafloor excavation, which could not only disturb/degrade seafloor habitats, but could suspend fine materials in the water column. These potential effects would be similar to those described for exploration drilling, but the affected sites would be larger and the effects would be distributed across a more extensive area.

Installation of pipelines across the terrestrial environment could affect habitats where the pipelines are located on land. Pipelines buried offshore would be less likely to affect habitats, as the trench would be about 11 m wide, and would be backfilled. The habitat is anticipated to be subject to natural restoration through time. On land, the amount of loss would include the size of the facility footprint, but also associated sites, such as gravel pits and transportation/access routes.

Construction activities can also indirectly affect fish, if onshore rivers and streams were disturbed, or terrestrial mammals and birds by displacing them from foraging, calving, or nesting areas around the facility (see 4.3.5 Fish, 4.37 Marine Mammals, 4.3.8 Terrestrial Mammals, and 4.3.6 Marine and Coastal birds).

Accidental Oil Spills and Gas Releases

In addition to small refined spills, which are analyzed under exploration, development activities contribute to the potential for both small and large (> 1,000 bbl) oil spills or gas releases. In the event of a small or large oil spill, subsistence-harvest resources such as fish, marine mammals, terrestrial mammals, and birds would be affected due to contact with crude or condensate in addition to refined products. The effects of small spills remain as described above.

Accidental large oil spills carry the highest risk to subsistence-harvest resources, and thus, subsistence harvests. Based on the Exxon Valdez Oil Spill findings in Prince William Sound, negative effects to specific subsistence species as well as to patterns of general subsistence use persisted several years, and still persist today, 25 years after the spill and cleanup efforts (Impact Assessment, Inc., 2011b, 2001; EVOSTC, 2014). After this spill, subsistence resources affected were fish, terrestrial mammals, shellfish, marine mammals, wild plants, birds, and bird eggs. Many subsistence users shifted harvests from marine mammals to salmon and other fish in the first three years following the Exxon Valdez Oil Spill (Impact Assessment, Inc., 2011, 2001; Integral Consulting, 2006). The primary reasons given by survey participants for the shift in harvest composition were the reduced availability of marine mammals and the relatively low risk of oil contamination in fish compared to perceived contamination in marine mammals and shellfish (Impact Assessment, Inc., 2011, 2001; Integral Consulting, 2006). In 2003, Marine mammal and marine invertebrate harvests continued to be lower than pre-spill levels in several communities (Integral Consulting, 2006).

A large oil spill would affect fish, fish habitat, and fish prey in many ways, including displacement, contamination and increased mortality to eggs. If nearshore oil were to weather and settle on benthic habitat it would most likely affect subsistence fish resources, altering their habitats and prey; depending on several factors, marine mammals used for subsistence could also be affected. A large spill event occurring in late summer could overwinter in the ice and result in contact with polynyas the following spring, affecting subsistence hunts for whales. However, weathering would decrease the volatility and toxicity of the spilled oil. Effects of a large spill on whales would be physiological, and include irritation or inflammation of the skin, coating of their scattered hairs with oil, which could reduce the hair's function (thought to be sensory or for communication), ingestion of oil and dispersants either directly or indirectly, and fouling of the baleen. Use of dispersants could also increase fear or perceptions of the tainting of subsistence foods; contamination through direct ingestion of dispersed oil by subsistence resources or through bioaccumulation; and cause deflection of marine mammals, resulting in inability to harvest them. Birds could be affected by a large spill contacting the spring lead system. This could affect a relatively large proportion of the eider population, thus affecting a subsistence resource. A large oil spill from a platform or pipeline could affect subsistence activities and reduce the availability of resources possibly longer than a single harvest season.

In the event of a natural gas release, methane would be released and rise through the water column due to pressure, volume, and the rate of release. Other factors affecting a gas release can be water temperature and the presence or absence of sea ice. When released in a blowout or rupture at depth, the water quality would be altered temporarily. This has the potential to affect fish utilized as a subsistence resource if the release depletes oxygen in the water or increases water temperature. Most gas escaping and contacting water would dissipate quickly, producing no effect on marine mammals. 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 higher concentration of CO_2 near the surface could affect chemical and biological processes and reactions at the water-air interface. (See 4.3.5 Fish, 4.3.6 Marine and Coastal birds, 4.3.7 Marine Mammals, and 4.3.8 Terrestrial Mammals).

Production

Production is the production of hydrocarbons throughout the life of the field. Many of the same IPFs that could arise from production activities were described for the development phase and those potential impacts are not repeated here.

Activities associated with production include vessel, aircraft, and vehicle traffic to operate/maintain facilities to produce hydrocarbons and move them to market. The same effects from those IPFs that could arise from production activities were described for the exploration and development phases, and those impacts are not repeated here.

Noise

There are no new sources of noise associated with the production phase.

Physical Presence

The presence of platforms and other facilities would not have an ongoing effect on subsistence-harvest patterns in the marine environment because subsistence hunts do not take place 60 mi offshore.

Discharges

There are no new sources of discharge associated with the production phase.

Habitat Alteration

Activities on areas adjacent to facilities (e.g., shorebase, pipelines, and access roads) would have a potential, ongoing effect of displacing terrestrial mammals and birds from foraging, calving and nesting sites. Production activities could affect various water resource environments (marine, estuarine, freshwater). Production activities should have limited effects on marine mammals in the Leased Area and adjacent areas with the primary source of disturbance from these activities analyzed in earlier phases.

Accidental Oil Spills

Small or large oil spills or gas releases are possible during oil and gas production activities. Impacts to subsistence resources from small or large oil spills or gas releases are analyzed under exploration and development.

Impacts of the Scenario through Time

This section provides analysis of impacts to subsistence-harvest patterns as they occur through the 77 years of the Scenario. This analysis addresses the particular oil and gas activities that could occur during each relevant time period and analyzes their impacts against the backdrop of a dynamic affected environment. Whereas previous sections have focused on identifying relevant IPFs and the types of environmental impacts they may cause, this section more specifically accounts for the level at which each IPF occurs during a given phase, the overlap of IPFs, and any additive or synergistic impacts which may result. In total, these sections tell the story of how the activities comprising the Scenario could affect subsistence-harvest resources and patterns through time.

The text below assumes the shorebase would be located in Wainwright, but the recommended coordination would apply, and would be equally effective, regardless of what community actually hosts the shorebase.

Exploration (Years 1-5)

During Years 1-5, the anticipated activities include:

- OCS
  - Seismic surveys (deep penetration and shallow hazard)
  - Exploration and delineation drilling operations
- Onshore
  - Construction activities that include an exploration base, supply boat terminal, air support base, and a search and rescue (SAR) base

During the exploration phase, deep penetration seismic surveys would occur and would typically involve two vessels during the open-water season (June-November). For open-water surveys, many subsistence resources, bowhead and beluga whales, seals, walrus, polar bear, fish and birds, could be disturbed during the subsistence hunts, although, to date, effects have not been documented (SRB&A, 2013a). Each survey would be short term, with individual surveys lasting 20-90 days, depending on the size of the survey area. Subsistence could be periodically affected during open-water surveys, but resources would continue to be available without significant effects for the harvest season. Close coordination with local community Alaska Native hunters concerning temporal and spatial considerations would reduce and help in mitigating effects on subsistence harvests.

Surveys conducted during other time periods, such as in-ice surveys (December) would occur when many subsistence resources are generally not harvested. However, resources such as seal, walrus, polar bear, and some fish are harvested during this time period, depending on the stage of the ice and the season. To this day, Wainwright whalers describe an on-ice survey that occurred in the late 1960's: they attributed their inability to successfully harvest a bowhead whale that season to anthropogenic noise associated with the seismic survey (Quakenbush and Huntington, 2010). If coordination with subsistence hunters takes place, the impacts from each seismic survey is expected to be negligible due to the duration and extent of each survey.

If mitigation measures are not used, activities could potentially interfere with a season's harvest, meaning that the level of effect for this portion of the Scenario could possibly be elevated to major.

There are, however, some recent examples of these types of activities for which analysis indicated negligible effects, including an open-water season seismic survey operation in the Chukchi Sea analyzed in 2013 (USDOI, BOEM, 2013a). For that survey, activities and anticipated impacts included noise, disturbance, and a small fuel spill. Although the study regarding marine subsistence use of the Chukchi Sea had been completed, BOEM did not receive reports of project interference with OCS subsistence harvest efforts.

Geohazard and Geotechnical surveys are typically conducted in association with exploration drilling, but in the absence of such drilling, these surveys could be conducted independently utilizing one to two vessels. The discharge of graywater and ballast water from these survey vessels could have localized effects on marine subsistence resources and fish.

Exploration drilling would occur during Years 3-5 of this period, with 12 exploration wells being drilled using 2 MODUs. An exploration drilling operation in the Chukchi Sea was analyzed in 2012. Even though BOEM's analysis of the 2012 exploration drilling operation anticipate effects from vessels, MODU, aircraft, physical presence, discharges, and habitat alteration, BOEM did not receive any reported effects on subsistence activity at the conclusion of the 2012 exploration operation. It is important to consider that aircraft noise not only potentially affects the prey, it is a source of hunter complaint (SRB&A, 2013b). These impact producing factors are not expected to have an effect on subsistence hunting as they will occur 60 miles offshore. If the above noted mitigation measures are followed regarding aircraft and helicopters, it is anticipated that this would reduce noise and result in a negligible effect on subsistence activities.

According to the Scenario, construction activities during this phase include: in Years 1-2, the completion of an exploration shorebase, air support base, and a search and rescue base and in Year 5, construction on the production shorebase and supply boat terminal begin.

Construction activities would produce noise from various types of equipment both on and offshore and this noise has the capacity to cause disturbance to whales, seals, walrus, other marine mammals, fish, and birds. The effects of noise from construction can injure subsistence resources and cause behaviors such as deflection or avoidance of traditional migration pathways or areas where hunting has taken place. Other construction equipment noise onshore can be caused by equipment and vehicles. Onshore, caribou and musk-oxen, in particular, are expected to avoid areas of construction activity unless migrations of those animals are underway (see Sections 4.3.7 and 4.3.8). Maximum mitigation of impacts to subsistence-harvest patterns will require close coordination between industry and the community(ies) along with the AEWC and the NSB Department of Wildlife Management during the beluga hunt to ensure that activities would not affect the traditional beluga hunt or the beluga migration northward in the spring (late June through early to mid-July). Avoidance of noise will be especially crucial, given traditional knowledge regarding beluga intolerance to anthropogenic noise. For example, flights and boating would need to arc northwest of the traditional beluga hunt and maintain 1,500 ft altitude. Boating traffic would also need to arc northwest to avoid the traditional beluga hunt. No traffic should occur south of Point Belcher because the beluga will be traveling from south to the north. If these measures are not implemented, subsistence harvests would likely experience major effects, particularly in regard to the important beluga hunt. As documented in Chapter 3, traditional knowledge observes that beluga are extremely sensitive to noise, particularly unaccustomed sounds. They react by deflecting into deeper water farther from shore to avoid the sound source. Without mitigation, it may be likely that the beluga would deflect and avoid the area entirely.

Moreover, development of gravel mines and road and shore-base construction will be a source of noise, traffic, and fugitive dust, all of which can impact subsistence harvest.

Impacts to subsistence from disruptions related to seismic surveys, exploration and delineation drilling activities, and construction of onshore facilities from noise, vessel and aircraft disturbance, discharges, and accidental small refined spills, specific to resources, would be:

- Bowhead and beluga whales could exhibit wariness and avoid areas of airgun noise, aircraft, and vessel presence. They may avoid subsistence hunting areas if seismic activities, vessel traffic, or air traffic occurred during their migrations. This would make obtaining whales more difficult. Bowhead whales are taken during the spring and fall hunts in Barrow and Wainwright, and bowhead and beluga are taken in the spring hunts in Barrow, Wainwright, Point Lay, and Point Hope as described in Section 3.3.2.
- Seals and walrus could be affected by airgun noise, vessels, and aircraft. Disturbances to these resources may cause displacement and dispersal, leading to more hunter difficulty and lower success in harvesting. Seals are taken during the primary hunting months in the open-water season (July to August) as described in Section 3.3.2. Walrus are primarily harvested during the northern spring migration and during the southward fall migration.
- Fish used for subsistence would experience minimal impacts offshore but in nearshore waters and shallow areas, the placement of ocean bottom nodes and cables could displace and disturb

fish migrations, potentially moving them away from subsistence fishing areas. Fish are harvested year round, as described in Section 3.3.2.

- Birds exhibit a degree of avoidance around vessels due to noise and physical presence. These effects are localized and the activities would not be conducted in areas of critical importance to birds. However, aircraft noise could displace birds from nesting areas. This could disrupt subsistence egg harvesting and bird hunting (see Sections 4.3.6, and 4.3.8). Birds are primarily hunted in summer months, as described in Section 3.3.2.

Small spills (<1,000 bbl) could occur during exploration activities. These spills could result from refueling activities during geological and geophysical activities (geohazard, geotechnical or marine seismic surveys), or exploration drilling activities, and are likely to consist of refined oils. The estimated total, as well as the annual number and volume of small refined oil spills during exploration activities are displayed in Tables 4-1 and 4-2.

Refined fuel spills from seismic surveys and exploration drilling could range from <1 bbl up to 50 bbl. A refined fuel spill would introduce hydrocarbons and temporary toxicity to the surface water. Due to the small size of these spills and their expected containment at the initial spill site, effects on subsistence-harvest patterns would likely be negligible. This would depend on the context of the spill, the area covered by the spilled product, and the amount of time the product was in the environment before cleanup efforts began. Uncontained spills occurring in summer could be difficult to clean up and could have lingering effects in the impacted tundra and habitats of onshore subsistence-harvest patterns. Small oil spills in winter on snow or frozen tundra typically would be contained and cleaned up relatively quickly. It might be impossible to completely cleanup spills that occur on broken ice. Spill that do occur are anticipated to evaporate, with spills of <1bbl weathering and dispersing within 10 hours and spill of 50 bbl dispersing within 3 days.

During exploration, a tug and a refueling barge may be moored in Kotzebue Sound for oil-spill response. It is anticipated that these vessels would be moored in the Goodhope Bay area of Kotzebue Sound. These vessels would be used for nearshore oil-spill response. From this barge, small spills of 50 bbl or less could occur. As fuel transfer operations present an elevated risk of fuel spills and potential environmental damage or effects on subsistence resources, transfer operations should be conducted under a fuel transfer plan, with adequate response equipment in place to provide for containment and recovery of any spilled fuel. Communities located closest to Goodhope Bay are Deering and Buckland, with the communities of Kotzebue, Noorvik, and Selawik also adjacent to Kotzebue Sound waterways. These communities, along with others located more inland, (see Section 3.3.2) harvest bowhead and beluga whales, seal, walrus, and polar bear, and a small spill, and as above, could realize the same impacts to their subsistence-harvest patterns.

Mitigation Measures

Wainwright hunting tracks for all resources in the marine environment in 2010, 2011, and 2012 extended over 30 miles offshore during the spring bowhead whale hunt (SRB&A, 2013a). Marine use extended from Kasegluk Lagoon at Aklialkatat Pass north to Point Franklin, as distance of up to 37 miles from shore. Hunting tracks from 2011 show that participants traveled slightly farther from Wainwright compared to 2010, with tracks extending north to Point Franklin into Peard Bay, and south to Kasegaluk Lagoon at Icy Cape Pass, with a maximum hunting distance offshore of approximately 40 miles. The farthest distance offshore that Wainwright hunters recorded traveling was 32 miles offshore. In 2012, the farthest distance offshore was approximately 26 miles, recorded during a walrus hunting trip (SRB&A, 2013a). The spring bowhead whaling effort is illustrated on Figures 4-13 – 4-16. The total hunting effort over three seasons is illustrated on Figure 4-13. It should be noted that the solid burgundy color mass off of Wainwright represents multiple overlapping hunting tracks over a three year period. Although marine subsistence hunts are variable from one year to the next, depending upon ice and wind conditions and sea states, the research is likely representative of the area of most concentrated marine subsistence based out of Wainwright, the closest community to the Leased Area.

To most fully mitigate impacts to subsistence-harvest patterns, any on-ice survey conducted on the Chukchi Sea coast from Icy Cape to Point Franklin and offshore up to 45 miles would need to be performed either well before bowhead whales neared the area during their spring migration, or after Wainwright officially called off the hunt. This would avoid direct conflict with this important subsistence activity. The bowhead whale hunt took place between February and June in the three years of a study designed to identify hunting activities in the marine environment (SRB&A, 2013a). Any associated air traffic from the shorebase to the Leased Area or to provide support for an on-ice seismic survey should also avoid the spring bowhead whale hunt. Flights should travel northeast at an altitude of 1,500, arcing north to avoid the area of whaling activity entirely, but also avoiding the Barrow Canyon, in coordination with the Alaska Eskimo Whaling Commission (AEWC) and the Wainwright Whaling Association. Flights could not avoid the hunt by flying south to avoid subsistence activities because bowhead whales travel from south to north along the Chukchi Sea coast, and southern overflights could cause the whales to deflect or become skittish. This mitigation could result in temporal suspensions of work and rerouting of transportation corridors (including air transport) to avoid spatial overlap of industrial physical presence during the hunt.

The same coordination and avoidance measures would need to be undertaken if an on ice-seismic survey were to be conducted in the vicinity of either Barrow or Point Hope, as both communities conduct spring bowhead whale hunts that are timed differently than at Wainwright.

By the same token, to most fully mitigate impacts from open-water seismic surveys, any such survey would need to be subjected to coordination with nearby communities to generate workable mitigation and avoidance measures. For example, at Wainwright the operation would need to communicate closely with the hunters and the NSB Department of Wildlife Management so as not to interfere with marine subsistence activities. Boat and air traffic would need to follow a corridor that avoids the primary offshore subsistence area, as previously described (Figure 4-13). Noise from airguns would also need to be assessed to determine any potential effects on subsistence marine harvest. If mitigation measures are not followed, the level of effect could likely be major.

Of particular concern in this and all subsequent phases of the Scenario would be the effect of anthropogenic noises on beluga whale hunts, which is of particular significance in Point Lay. As previously described in Chapter 3, traditional knowledge describes the effects of anthropogenic noise on beluga, driving them away from shore into deeper water and making them skittish and difficult to hunt. Moreover, recently BOEM was informed that belugas arrive in the vicinity of Point Lay from deeper water farther offshore rather than traveling up the coast (Robert Suydam, Ph.D., Barrow Public Hearing Transcript, December 3, 2014, page 51). For these reasons, subsistence hunters would like to see a mitigation measure implemented that would suspend OCS activities until after the beluga hunts at Point Lay and Wainwright or July 15, whichever comes first.

A discussion of mitigation measures to decrease impacts from oil and gas activities resulting from Lease Sale 193 is in the 2007 FEIS (pages II-9 through II-11). To further minimize impacts on subsistence harvests, Federal laws and associated regulations (MMPA, ESA, etc.), along with lease stipulations can provide mitigation measures to protect subsistence-harvest patterns. Lease stipulation measures to minimize effects of activities include:

- Stipulation No. 4 Industry Site-Specific Monitoring Program for Marine Mammal Subsistence Resources
- Stipulation No. 5 Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Marine Mammal Subsistence Harvesting Activities

The 2013 NMFS Biological Opinion lists terms and conditions that must be followed by lessees and operators. One of the terms and and conditions is: "At all times when conducting seismic-related or exploratory drilling-related activities, BOEM/BSEE shall require their authorized operators to possess on board the seismic source or drilling vessel a current and valid Incidental Harassment Authorization or incidental take authorization issued by NMFS under section 101(a)(5) of the MMPA."

During construction of the shorebase, roads, and similar infrastructure that would require development of land-based gravel mines, impacts can be further mitigated by operators coordinating with local subsistence harvesters to learn not only of hunting but also gathering activities. Gravel mine locations and designs would need to incorporate ways to avoid or minimize effects of the gravel mine site, as well as use dust abatement practices so as not to affect browse or gathering of greens or berries.

Compliance with these stipulations and integration of specific mitigations described above into work practices would likely reduce effects so as not to exceed the moderate level. If mitigation measures are not followed, the level of effects would likely elevate to a major level.

Conclusion

This time period typically involves activities/IPFs that have some direct impact to subsistence-harvest patterns. For a more in-depth biological discussion for each species utilized for subsistence, see Sections 4.3.5, 4.3.6, 4.3.7, and 4.3.8. Marine mammals, whales, seals, and walrus generally move away from localized sources of disturbance and those sources of disturbance are anticipated to occur short-term and in localized areas. Fish used for subsistence could be affected by these activities. Seismic surveys could ensonify fish habitat and affect fish behavior by potentially deflecting them from subsistence-harvest use areas. Accidental, small refined spills could lead to acute toxicity in fish. Few birds would be repeatedly exposed to disturbances; the greatest potential for direct effect to birds comes from the physical presence of vessels in the marine environment and birds striking vessels. Terrestrial mammals are anticipated to exhibit behavior effects or have reduced access to migration pathways and grazing areas due to construction and the presence of field and construction crews. These short-term, localized effects do not persist across seasons. Due to the limited time and the specific locations of activities during this phase, some resources could become more difficult to harvest overall for a season. Due to these potential impacts to subsistence-harvest patterns, the impact anticipated is mostly minor and likely would not exceed the moderate level as long as there is close coordination between industry and the marine subsistence hunters and community members, and if workers are housed and transported to avoid conflict, particularly during the spring bowhead whale and beluga hunts. If mitigation measures are not followed, the effect will likely be elevated to a major level. If the production base is constructed between Icy Cape and Point Belcher, the marine subsistence hunters of Wainwright would likely experience a major level of effect as the associated noise may result in displacement or skittishness of subsistence species, resulting in reductions in or even inability to harvest.

Exploration and Development (Years 6-9)

Exploration activities during this period would continue in roughly the same manner and frequency as during the preceding period, analyzed above. This period also includes the completion of the shorebase and supply boat terminal in Year 6 along with both offshore and onshore pipeline construction occurring during each open-water season.

Construction of an offshore oil pipeline (160 miles in Years 6-9), and an onshore oil pipeline (300 miles in Years 6-9) could create noise and disturbance to subsistence-harvest resources. The shorebase would support offshore work and then become the connection point for the trunk pipeline from the hub platform and the pipeline across the National Petroleum Reserve in Alaska (NPR-A). Marine and terrestrial mammals utilized for subsistence would be affected by construction and dredging noise. The Scenario identifies the location of the shorebase between Icy Cape and Point Belcher. The pipeline would come onshore at that location as well, likely during the open-water season, and would conflict with subsistence hunts for seal, walrus, caribou, fish, and birds—primarily for the community of Wainwright. A review of maps of marine subsistence over three seasons based out of Wainwright illustrates the sheer density of hunting effort (SRB&A, 2013a; Figures 4-14 through 4-16). The most harvested resource to be disrupted for these communities would be the bearded seal, taken by Wainwright. As described in the previous section, bowhead whales are key subsistence resources for these communities and any effects from construction may impact these resources offshore if spring whaling were to occur into the month of June, as occurred in 2010 (SRB&A, 2013a). In the years that the hunt was documented in BOEM OCS Study 2013-211, whaling camps were constructed on ice within half of a mile of Point Belcher (Figures 4-14 through 4-16) (SRB&A, 2013a). Whales were struck and harvested north of Point Belcher between Point Belcher and Point Franklin. The beluga whale harvest for Wainwright and Point Lay could also be affected during open-water pipeline construction. This culturally significant resource is harvested by Wainwright in July and by Point Lay in June and July. The hunting and harvesting of beluga whales for each community occurs in the area where an onshore pipeline could meet the first onshore pump station (see Section 4.3.11).

During offshore pipeline construction and installation, sediment displacement and soil deposition from trenching and burial might cause changes in food resources for species utilized as subsistence. For example, walrus (hunted by the communities of Barrow, Wainwright, and Point Lay) are foragers that feed on benthic bivalve mollusks and other lower trophic marine organisms. Pipeline installation during the open-water season would also add increased vessel presence in the Leased Area and between the Leased Area and Wainwright or Barrow. Offshore pipeline effects to subsistence-harvest patterns 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-harvest and use periods.

The onshore pipeline would affect subsistence during the active construction periods (preferably winter months) and certain effects would continue for the operational life of the pipeline. The pipeline, over the life of the Scenario, would total 300 miles from the Chukchi Sea, across the NPR-A to Prudhoe Bay where it would connect with the Trans-Alaska Pipeline System (TAPS). Onshore pipeline construction would occur during the winter, crossing subsistence resource habitats and hunting use areas which could affect the resources and access to the use areas. Potential effects to subsistence-harvest patterns would be behavioral changes in animals, such as increasing wariness or skittishness. Effects on subsistence users would be less successful hunts due to avoidance by animals of traditional areas. Further, effects occur as hunters have more difficulty accessing traditional hunting areas, though ensuring access would mitigate this effect. For example: allowing crossing of roads and rights-of-way, elevating the pipeline, limiting air traffic to 1,500 ft altitude, and similar measures.

The pipeline may pass close to Atqasuk and Nuiqsut, creating a potential barrier to migratory animals and human travel, and affecting subsistence hunts associated with these two communities. These effects could be major.

Shorebase and supply boat terminal construction activities and disturbance would remain the same as during the exploration phase.

The potential for small refined spills (<1,000 bbl) continues in the Exploration and Development period. These spills could occur during exploration as described above, or during early development activities (i.e. facility construction and pipeline installations). Spills during this phase would come from similar sources, with the same effects on resources as described and analyzed during Period 2.

During this phase, as analyzed in Years 1-5, nearshore oil-spill-recovery vessels would be moored in Kotzebue Sound; impacts would be the same as for Period 1.

Mitigation Measures

Due to the high frequency of documented marine subsistence use offshore of Wainwright during the open-water season, a viable mitigation measure would be construction of the pipeline from shore to about 40 miles offshore during the winter rather than the open-water season, or rerouting the pipeline to avoid affecting marine subsistence areas used by Chukchi Sea communities. It would be important to coordinate the effort with the AEWC and the Wainwright Whaling Captains Association to avoid inadvertent conflicts with the bowhead whale hunt, which has been documented to commence as early as February in Wainwright (SRB&A, 2013a).

Other mitigation measures that could reduce the effects of the pipeline on Atqasuk and Nuiqsut subsistence include:

- Elevating the pipeline to allow humans and migratory species passage beneath the pipeline, even in the deepest of winter snows. Collaboration with the NSB Department of Wildlife Management and residents of Wainwright, Barrow, Point Lay, Atqasuk, and Nuiqsut, and possibly Anaktuvuk Pass and Point Hope, would be necessary to determine pipeline height and placement
- Close collaboration and communication with hunters in Atqasuk and Nuiqsut. Wainwright and Barrow to avoid disturbance of traditional subsistence harvests and travel
- Period meetings with each community to provide updates regarding industrial activities, mitigation and monitoring efforts, and to seek local input as to effectiveness of efforts to date.
- Winter construction of an onshore pipeline could reduce effects to most subsistence activities (rather than summer onshore pipeline construction, which could create conflict) although the inland communities of Atqasuk and Nuiqsut hunt for caribou, fish under ice, and trap furbearers during the winter. Since construction activities concentrated along the onshore pipeline route could disturb/displace subsistence resources and disrupt these subsistence activities, coordination with these communities would be necessary.

Offshore effects of pipeline construction on marine subsistence activities could be mitigated through

- Construction of the pipeline during winter in the area of greatest documented marine use offshore of Wainwright (Figures 4-13 through 4-16, SRB&A, 2013)
- Coordinating pipeline construction through communication call centers to interface with subsistence hunters
- Coordinating pipeline construction in communication with the AEWC and the Wainwright Whaling Captains Association from January through June each year of construction.

If these mitigation measures are not implemented, the effects on subsistence harvest could be elevated to a major level of effect.

Similarly, there will need to be a close coordination with Wainwright regarding the crew transits via vessel or aircraft would mitigate impacts. Aircraft should fly at 1,500 ft altitude to avoid disturbing subsistence species and subsistence hunters. Aircraft should be limited to hours that would avoid peak subsistence use – for example, early morning or evening. These times would have to be determined through conversations with the marine hunters and community of Wainwright and it is likely that a communication center will be necessary. Vessel traffic should similarly be limited in time and space to mitigate and reduce potential conflicts with subsistence hunting.

Discussions with Barrow, Wainwright, Atqasuk, Nuiqsut, and possibly Anaktuvuk Pass, Point Lay, and Point Hope community members could result in elevating the onshore pipeline could provide safe passage for people traveling on snowmachine on deep snows.

The location and use of gravel mine sites in the vicinity of local communities could be a source of potential conflict with onshore subsistence use. Again, close coordination with local communities would be an effective way to mitigate impacts. Noise and possibly fugitive dust may be of concern to subsistence harvesters, and early planning efforts could mitigate or eliminate effects. Moreover, the presence of large gravel trucks on roads is a potential sources of conflict with subsistence users. Signage in Iñupiaq and close community coordination might assist in reducing effects.

Close coordination should also take place in Atqasuk, as it lies within the pipeline corridor (See Figure 4-11 in Section 4.3.9). The best placement and height of the pipeline should be identified in close collaboration with Atqusak to ensure the least amount of impediment for caribou migration and subsistence hunting. Timing of construction is also crucial to ensure that potential conflicts with subsistence are avoided or reduced. Timing of vehicular traffic throughout the life of the Scenario will also be a critical source of discussion to alleviate effects.

Conclusion

This phase of the Scenario involves the same activities as the exploration phase with overlap of activities between this and the previous phase. Effects would increase due to the addition of pipeline construction and installation activities offshore and onshore. Pipeline construction and placement would have effects on subsistence resource habitats and hunting area access. Effects from these would cause impacts due to displacement and can cause a reduction of, or no access to, traditional hunting areas, potentially resulting in more difficult or less successful harvests. A permanent loss of resource or traditional hunting use habitats from displacement could persist across seasons. Other resources such as bowhead and beluga whales, seal, walrus, fish, and birds, could be affected during open-water season construction activities. The level of effect could range from negligible to major, largely depending on coordination to mitigate and monitor effects of industrial activities on traditional subsistence harvests. For example, timing pipeline construction during the early winter or mid-winter would alleviate effects on marine subsistence hunts, which occur during from early spring through the open-water season.

Through incorporation of specific mitigation and monitoring efforts described above, the level of effect could be reduced to range from minor to moderate. There is a strong chance that in spite of mitigation, monitoring, and coordination efforts, adverse impacts could disrupt subsistence activities or make subsistence resources unavailable for use or only available in greatly reduced numbers for a substantial portion of a subsistence season for Wainwright, Atqusak, and Nuiqsut.

Exploration, Development, and Production (Years 10-25)

This time period includes the same activities and effects as described in the Exploration and Development Phase. Impacts from exploration and development activities would occur as analyzed above. Exploration drilling continues during this period and impacts from that activity are included. There is new construction activity with up to six platforms will be installed and up to four drill rigs in operation. Meanwhile, oil production could commence, entailing the operation of OCS platforms and associated pipelines.

New direct effects include the physical presence of platforms in the marine environment. During this Period, 6 gravity-based structures would be installed in Years 10, 13, 16, 19, 22, and 24. As these platforms become permanent, marine noise levels could increase from crew transports arriving at helicopter landing pads, mud pumps, drawworks for reeling in drilling lines, gas turbines, generators, compressors, heaters, coolers, and cranes. Of particular concern to marine subsistence would be daily helicopter flights to each platform. This could result in a total of 36 daily flights to and from the shorebase near Wainwright over the most densely used subsistence area offshore of Wainwright. The effects on marine subsistence hunting, described previously, will increase substantially. This noise could affect subsistence resources such as whales, seals, walrus, and fish. As explained in the IPF section, noise could have effects on subsistence which may include changes in deflection and any other changes as documented in biological sections 4.3.5 Fish, 4.3.7 Marine Mammals, and 4.3.6 Marine and Coastal Birds.

During this phase, oil production is anticipated to begin in Year 10 with subsea wells being drilled from mobile platforms in Years 12-23. These subsea wells would be linked to production platforms with pipelines placed in both the exploration and development phase, described above. Offshore, oil pipeline construction and placement would continue in Years 13, 16, 19, 22, and 23. These pipelines would be constructed to link the Anchor Field and the Satellite Field production platforms. Satellite Field A2 would be constructed in Year 24. See Sections 4.3.5, 4.3.6, 4.3.7, and 4.3.8 for descriptions of impacts to subsistence resources. These Scenario activities will occur 60 miles offshore and are unlikely to have a direct effect on subsistence. Instead, effects would be incurred from aerial and ship transport from the shorebase to the Lease Area, pipeline construction, and any associated anthropogenic noise or fugitive dust from the shorebase and ancillary developments (e.g. gravel mines and roads as described in above in Exploration and Exploration and Development). Since most offshore Scenario activities would occur in the open-water season, (July through late October or early November), subsistence could be impacted since these are the primary months of harvest for most subsistence harvests.

The level of effects is expected to range from minor to moderate, considering the number of helicopter flights that have the potential to 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 Wainwright.

Small Oil Spills

Small oil spills during this phase include crude or condensate spills, or diesel spills. Small oil spills are analyzed in Section 4.1.2.5. Tables 4-1 and 4-2 describe assumptions about small oil spills. The small refined spill impacts would be the same as previously described in Years 1-5. They would have minimal effects on marine mammals due to their expected containment, minimal contact with habitat, and brief persistence in the environment due to their size and environmental weathering. Crude oil can persist on water or on the shoreline longer than refined fuel spills; how long it lasts is dependent on environmental conditions at the time of the spill and the substrate of the shoreline.

An estimated 220 small crude spills >1 bbl could occur during the 44-year oil production period for Alternatives I, III, or IV; this is an average of 5 spills per year (Table 4-2). An estimated 260 refined oil spills >1 bbl could occur during the 44 year oil production period for Alternatives I and III; an average of 6 spills per year (Table 4-2). The same number of refined spills occurs over the 44 year gas sales production period. Overall, an estimated 11 crude and refined spills >1 and <1,000 bbl are assumed to occur each year for Alternatives I, III, IV during Years 10-30. Of the 2 small crude spills >500 bbl, one is assumed to occur offshore and one onshore from the 300 mi (483 km) pipeline.

Small oil spills have the potential to impact subsistence-harvest resources and hunting patterns indirectly by creating a perception that the resource has been contaminated. If that perception becomes pervasive, subsistence users would reduce their harvests of a particular resource. An oil spill of any volume into a river system or lake could have effects on subsistence fish harvests and this loss of some portion of subsistence fish harvests would affect the majority of communities near the Leased Area. Subsistence users typically would allow some period of time for contaminated resources or areas to recover following exposure to oil, effectively reducing the total resource amount and the total harvest area acreage available to them for the subsistence harvest. This may result in a major level of effect, depending upon the timing of the spill, the quantity spilled, and subsistence resources perceived to be affected. Impacts include disruption of subsistence activities or subsistence resources becoming unavailable, undesirable for use, or only available in greatly reduced numbers for a substantial portion of a subsistence season for any community. For a discussion of effects on each resource see Sections 4.3.5, 4.3.6, 4.3.7, and 4.3.8.

Large Oil Spills

This discussion and analysis will utilize Section 4.1.2.5 (subsection on Large Oil Spills) and Table 4-3 for assumptions of impacts from large oil spill(s). The assessment of large oil-spill impacts are based on a combination of factors, including the oil type, spill size, spill duration, weathering, paths assumed for this analysis that the spill(s) follow, and the probability of one or more large spills occurring. Large oil spills analyzed here include a pipeline spill (1,700 bbl) and a platform spill (5,100 bbl) of crude oil, diesel and condensate. Timing of the spill and the medium affected (ice, tundra, open-water, etc.) are factors to be considered during analysis. Appendix A further describes the many facets of large oil-spill assessment.

Large oil spills, though unplanned events, are probably the most significant potential source of effects attributable to activities on the Leased Area. Effects to specific subsistence species, as well as to the more general patterns of subsistence resource use, persisted in Prince William Sound for several years after the Exxon Valdez Oil Spill and subsequent cleanup effort. The Exxon Valdez Oil Spill demonstrated that a very large spill could affect subsistence-harvest patterns in a large region.

A pipeline or platform spill could affect subsistence activities by reducing the availability and/or accessibility of subsistence resources, potentially for periods longer than a single harvest season (USDOI, MMS, 1990b). The effects of a large spill occurring on the Leased Area to subsistence-harvest patterns, depending on the time and location of the spill event, would affect resources and subsistence hunting use area access for the harvest of marine mammals. For the NSB communities described in Section 3.3.2, marine mammals are the most important subsistence resource, both culturally and as a traditional food source. If a large spill were to occur, bowhead whale hunts could be disrupted, as could the hunts for beluga whale, bearded seal, walruses, and other marine mammals. Hunting and harvesting disruptions would occur from the direct oiling of animals, or by oil becoming part of ice floes used by these resources on their northern migrations or used by hunters for preparing their harvests. If animals are contacted by oil, they may be considered undesirable and become more difficult to hunt because of the physical conditions. Animals are also likely to become wary, either because of the spill itself or from the “hazing” of marine mammals, which is a standard spill-response technique encouraging them to leave the area affected by a spill.

The potential effects of oil spills on whales and whaling is a concern for all marine subsistence-harvest patterns overall. Marine mammals and fish typically comprise 60% of a coastal community’s diet, and the ocean is frequently referred to in public testimony as “the Iñupiat garden.” Pipeline and platform spills could affect migrating anadromous fish in nearshore river deltas, as well as species that use oiled coastal and other nearshore habitat, such as breeding caribou and nesting birds.

Additional effects from large 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 leaving them less desirable, possibly altering or preventing the subsistence hunt.

Seals, walrus, polar bears, and some bird populations contacted by oil could potentially be impacted. Subsistence users may become concerned about tainting, which may result in short-term but serious effects due to potential loss of these resources. Oil-spill-cleanup activities could produce additional effects on subsistence activities, causing displacement from habitats and subsistence hunters from their traditional use areas.

Impacts would be experienced by communities adjoining the origin of the Chukchi Sea and by communities away from the Leased Area that are far removed from a large oil spill. Concerns about subsistence harvests and subsistence food consumption would be shared by all Iñupiat and Yup'ik Eskimo, including the Russian Chukchi people who reside in communities located in the Chukchi and Bering Seas along the migratory corridor used by whales and other migrating species. Concerns about oiled or tainted resources in these communities could seriously curtail traditional practices for harvesting, sharing, and processing important subsistence species. All communities would share concerns over the safety of subsistence foods, the health of the whale stock for future harvests, and the potential for International Whaling Commission (IWC) to reduce whale strike quotas to protect the remaining stocks.

Large spills could affect subsistence-harvest patterns by reducing populations of subsistence species, contaminating subsistence species, contaminating the marine environment, or rendering these resources unfit to eat. Effects which could reduce the amount of subsistence foods harvested, cause changes in traditional diets, increase risks and wear and tear on equipment if users travel farther to obtain subsistence resources, and cause social stress due to the reduction or loss of preferred foods harvested in the traditional fashion (USDOI, BLM and MMS, 2003; USDOI, BLM, 2004, 2005, 2006; USDOI, MMS, 1987, 1990b, 1998, 2001, 2003, 2004, 2006a,c).

While spills can occur in the marine environment or on land, marine oil spills have the greatest potential to affect subsistence-harvest resources and alter harvest practices. Impacts related to the exposure of marine subsistence resources to oil from spills are analyzed in Sections 4.3.5, 4.3.6, and 4.3.7. For subsistence resources onshore, Section 4.3.8 analyzes onshore contact of large oil spills to species used for subsistence.

Conditional Probabilities. This section describes the conditional probabilities, estimated by the OSRA model, of a large oil spill in the Chukchi Sea contacting important subsistence ERAs and LSs that are important to these resources and harvests. Due to adjustments (size/shape) to ERA polygons, reduction in launch areas, other model refinements and changes in the Scenario, BOEM has updated the oil spill analysis below. The ERAs and LSs used in this analysis are shown in Appendix A, Table A.1-12 and Maps A-2b through A-2f which show their spatial locations. Conditional probabilities are based on the assumption that a large spill has occurred. Contact from a large spill in winter could affect polar bear hunting and sealing. During summer, a large spill could affect whaling for bowhead and beluga whales, and hunting for seals, walrus, fish, and birds.

Unless otherwise noted, the conditional probabilities are summarized for all LAs and PLs during summer or winter within 30 and 360 days. The corresponding tables in Appendix A are Tables A.2-27, A.2-30, A.2-33, A.2-36, A.2-39, A.2-42, A.2-51, A.2-54, A.2-57, A.2-60, A.2-63, A.2-66, A.2-69, and A.2-72. The summer and winter seasons analyzed below are the time periods when a large spill could start. These discussions are separated by the community affected with corresponding ERAs and LSs.

Summer—Barrow

The OSRA model estimates a 3-10% chance of a large spill starting at all LAs and PLs contacting important Barrow subsistence ERA42 (Barrow – East Arch) within 30 days and a 4-11% chance of contact within 360 days. For ERA42), there is 3-7% chance of contact within 30 days and a 5-8% chance within 360 days from all LAs. There is a 3-10% chance of contact within 30 days and a 4-11% chance within 360 days from all PLs.

The LSs 81 (Peard Bay/Point Franklin), 82 (Skull Cliff), 83 (Nulavik, Loran Radio Station), 84 (Will Rogers and Wiley Post Memorial), 85 (Barrow/Browerville/Elson Lagoon), and 88 (Cape Simpson) have a <0.5-10% and a <0.5-10% chance of contact within 30 and 360 days, respectively, from all LAs and PLs. For all individual LSs for large spills originating at LAs there is a <0.5-6% chance of contact within 30 days and a <0.5-7% chance within 360 days. For a large spill originating at all PLs, there is a <0.5-10% chance of contact within 30 days and a <0.5-10% chance of contact within 360 days.

Winter—Barrow

The chances of winter contact are generally lower. The OSRA model estimates a <0.5-5% chance of a large spill contacting ERA41 (Barrow - Chukchi) within 30 and 360 days, respectively from all LAs and PLs. The chance of contact is <0.5-1% chance of contact for ERA42 (Barrow-East Arch) within 360 days from all LAs and PLs.

The LSs 81-85 have a <0.5-4% chance of contact within 30 and 360 days, respectively. LS 86 has a <0.5-1% chance of contact within 360 days from PL 8 and PL 9.

Summer—Wainwright

For all LAs, the OSRA model estimates a 6-34% chance of contacting ERA40 (SUA: Icy Cape-Wainwright) within 30 days and a 7-35% chance of contact within 360 days. For all PLs, there is a 9-62% chance of contact within 30 days and a 10-62% chance of contact within 360 days. The LSs, 76 (Akoliakatak Pass/Avak Inlet/Tunalik River), 77 (Mitliktavik/Nivat Pointik/Nokotlek Point/Ongorakvik River), 78 (Point Collie/SigeakrukPoint), 79 (Point Belcher/Wainwright), 80 (Eluksingiak Point/Kugrua Bay), 81 (Peard Bay/Point Franklin) have a <0.5-4% chance of contact from all LAs within 30 and 360 days, respectively. From all PLs, there is a <0.5-6% chance of contact within 30 and 360 days respectively.

Winter—Wainwright

In winter, the OSRA model estimates a 2-21% chance of contact from all LAs within 30 days to ERA40 (SUA: Icy Cape-Wainwright) and a 3-24% chance of contact within 360 days. There is a 3-65% chance of contact from all PLs within 30 days and a 6-66% chance of contact within 360 days. The LSs 76-81 have a <0.5-2% chance of contact from all LAs within 30 and 360 days, respectively. From a spill originating from all PLs, there is a <0.5-4% chance of contact within 30 and 360 days, respectively.

Summer—Point Lay

The OSRA model estimates a 1-11% chance from all LAs contacting ERA39 (SUA: Point Lay-Kasegaluk) within 30 and 360 days, respectively. There is a 1-31% chance of contact from all PLs within 30 and 360 days, respectively. The LSs 70 (Kuchaurak/Kuchiak Creek), 71 (Kukpowruk River/Sitkok Point), 72 (Point Lay/Siksrikpak Point), 73 (Akunik Pass/Tungak Creek), 74 (Kasegaluk Lagoon/Utukok River), 75 (Icy Cape/Akeonik), and 76 (Avak Inlet/Tunalik River) have a <0.5-4% chance of contact from all LAs and PLs within 30 and 360 days, respectively.

Winter—Point Lay

The OSRA model estimates a <0.5-5% chance from all LAs contacting ERA39 (SUA: Point Lay-Kasegaluk) within 30 days and a 1-5% chance within 360 days. From all PLs, there is a 1-27% chance of contact within 30 days and a 1-28% within 360 days. The LSs 70-76 have a <0.5-1% chance of contact within 30 and 360 days from all LAs, respectively. There is a <0.5-3% chance of contact within 30 and 360 days from all PLs, respectively.

Summer—Point Hope

The OSRA model estimates a <0.5-7% chance from all LAs and PLs contacting ERA38 (SUA: Point Hope-Cape Lisburne) within 30 and 360 days, respectively. The LSs 62 (Atosik Lagoon/Kuropak Creek), 63 (Cape Thompson), 64 (Point Hope/Ipiutak lagoon), 65 (Cape Dyer/Cape Lisburne/Buckland), and 66 (Ayugatak Lagoon) have a <0.5-2% chance of contact from all LAs within 30 and 360 days. For all PLs, there is a <0.5-3% chance of contact within 30 days and a <05.-4% chance within 360 days.

Winter—Point Hope

The OSRA model estimates there is a <0.5-6% and a <0.5-7% from all LAs and PLs contacting ERA 38 (Point Hope/ Cape Lisburne) within 30 and 360 days, respectively.

LSs 64 (Kukpuk River, Point Hope), 65 (Buckland – Cape Lisburne), and 66 (Ayugatak Lagoon) all have a <0.5-1% chance of contact for 30 and 360 days from all LAs and there is a <0.5-1% chance of contact for 30 days and a <0.5-3% for 360 days from all PLs.

Kivalina, Kotzebue and vicinity, Shishmaref, and Wales

The communities of Kivalina, Kotzebue, Shishmaref, and Wales were analyzed in the 2007 FEIS IV.C.I.(1)(b) for oil spill contact conditional probabilities to ERAs and LSs. This analysis indicated that contact from all LAs and PLs ranged from <0.5-2%. The 1% chance of contact to LSs including the communities of Kivalina and Kotzebue and the 2% chance of contact of the LS near Wales within 30 and 360 days originated from LA 9 and PL1. LA 9 and PL1 are no longer relevant to this analysis since no leases were issued in LA 9 and the supporting pipeline is not considered within this Leased Area analysis.

Due to Leased Area changes related to launch areas, pipeline routes, and issued leases, spill contact conditional probabilities indicates that all ERAs (ERA13 Kivalina/ Kotzebue; ERA5 Shishmaref/Wales) have a <0.5% chance of contact within seasons analyzed (summer/winter) and within 30 and 360 days respectively. All land segments which correspond with ERAs 13 and 5 (Land Segments 40-63) have a <0.5% chance of contact within all seasons, time periods, and from all LAs and PLs (Map A-2a).

Summer—Far East Russian Communities (Southern)

The OSRA model estimates a <0.5-1% chance of a large oil spill from all LAs and PLs contacting important Russian Chukchi Sea coastal community subsistence ERA 4 (Naukan/Russia) within 30 and 360 days.

The LSs 36 (Mys Chechan), 37 (Chegitun/Mys Volnistyy), 38 (Inchoun), and 39 (Naukan) have a <0.5-1% of contact in 30 days and 360 days respectively. The LSs 36 (Mys Serdtse Kamen), 37 (Chegitun/Mys Volnistyy), and 38 (Inchoun) are potential harvest areas for the community of Chegitun (seasonal camp) and the communities of Inchoun (pop. 362), Uelen (pop. 678), and Naukan (pop. 359).

Winter—Far East Russian Communities (Southern)

The OSRA model estimates a <0.5-6% chance of a large oil spill starting at all LAs and PLs within 30 and 360 days during winter.

The LSs 36 (Mys Chechan), 37 (Chegitun/Mys Volnistyy), 38 (Mys Uelen), and 39 (Naukan/Mys Uelen) have a <0.5-2% chance of contact within 30 days and a <0.5-4% chance of contact within 360 days.

Summer – Far East Russian Communities (Northern)

The OSRA model estimates a 1-5% chance of a large oil spill from all LAs and PLs contacting ERA 3 (SUA: Uelen/Russia) within 30 and 360 days, respectively.

The LSs 31 (Alyatki/Kolyuchin Bay), 32 (Eynenekvyk), 33 (Neskan), 34 (Emelin/Tepken), and 35 (Enurmino/Mys Neten). The LSs 31 (Alyatki/Kolyuchin Bay), 32 (Eynenekvyk), 33 (Neskan), 34 (Emelin/Tepken), and 35 (Enurmino/Mys Neten) have a <0.5-1% chance of contact within 30 days and a <0.5- 2% chance of contact within 360 days. LSs 34, 35, and 36 are potential harvest areas for the community of Enurmino (pop. 304).

Winter – Far East Russian Communities (Northern)

The OSRA model estimates a <0.5% chance of a large oil spill from all LAs and PLs within 30 days and 360 days, respectively.

The LSs 31 (Alyatki/Kolyuchin Bay), 32 (Eynenekvyk), 33 (Neskan), 34 (Emelin/Tepken), and 35 (Enurmino/Mys Neten) have a <0.5-3% chance of contact within 30 days and a 1-5% chance of contact within 360 days.

Other Far East Russian Communities with Land Segment Contact

Proceeding north along the Chukchi Sea coast of Russia (Map A-3a), the LSs 30 (Neutepynmyn/Laguna Kunergin) is a potential harvest area for the communities of Alyatki (possible seasonal hunting camp) and Neshkan (pop. 704). In summer, LS 30 has a <0.5-2% chance of contact from all LAs and PLs within 30 and a 1-2% chance of contact within 360 days. In winter, contact percentages for LS 30 are estimated to be 1-3% within 30 and 2-4% within 360 days.

The LS 29 (Mys Onman/Vel'may) is a potential harvest area for the community of Nutpel'men (2000 pop. 155). In summer, LS 29 has a <0.5-1% chance of contact from all LAs and PLs within 30 days and 360 days. In winter, LS 29 has a 1-2% chance of contact from all LAs and PLs and a 1-3% chance of contact from all LAs and PLs within 30 and 360 days.

The LSs 26 (Ekugvaam/Kepin/Pil'khin), 27 (Laguna Nut/Rigol'), and 28 (Vankarema/Laguna Vankarem) are potential harvest areas for the communities of Rigol' (pop. unknown) and Vankarem (pop. 184). In summer, LSs 26-28 have a <0.5 – 1% chance of contact from all LAs and PLs for the 30 and 360 day periods. In winter, LSs 26-28 have a <0.5-2% chance of contact from all LAs and PLs within 30 days and and 360 days.

The LSs 21 (Laguna Pil'khikay/Pil'khikay), 22 (Rypkarpyy/Mys Shmidta), 23 (Emuem/Tenkergin), 24 (LS 24), and 25 (Laguna Amguema/Yulinu) are potential harvest areas for the communities of Rypkarpyy (pop. No Data) and Cape Shmidt (pop. 492). In summer, LSs 21-25 have a <0.5-1% chance of contact from all LAs and PLs within 30 and 360 days respectively. In winter, LSs 21-25 have a <0.5-1% chance of contact from all LAs and PLs within 30 and a <0.5-2% chance of contact within 360 days.

The LSs 18 (Pil'khikay/Laguna Rypil'khin), 19 (Laguna Kuepil'khin/Leningradskiy), and 20 (Polyarnyy/Pil'gyn) are potential harvest areas for the communities of Leningradskii (pop. 764), and Pil'gyn (pop. unknown). The community of Polyarnyy (2002 pop. 0) was a mining settlement which was abolished in 1995. In summer and winter, contact percentages within the 30 and 360 day periods are <0.5-1% for spills originating from all LAs and PLs.

The LSs 15 (Mys Billingsa/Laguna Adtaynung) and 16 (Mys Emmatagen) are potential harvest areas for the community of Billings (pop. 211). In summer, contact percentages for these LSs from spills originating from all LAs and PLs are <0.5% within the 30 and 360 day periods. In winter, LSs 15-16 have a <0.5-1% chance of contact from all LAs and PLs within 30 and 360 days.

Wrangel Island

The LSs 7 (Kosa Bruch), 8 (E. Wrangel Island/Skeletov/Klark), and 9 (Nasha/Bukhta Rodzhers) are potential harvest areas for the community of Ushakovskoe on Wrangel Island (pop. unknown). The LSs 7, 8, and 9 have a <0.5-2% chance of contact from summer spills originating at all LAs and PLs within 30 days and within 360 days. In winter, there is a <0.5-2% chance of contact to LAs 7-9 from spills originating at all LAs and PLs within 30 and 1-2% chance within 360 days.

Combined Probabilities

Combined probabilities express the percent chance of one or more large oil spills occurring and contacting a certain environmental resource area (ERA) or land segment over the Scenario. The combined probabilities analyzed are located in Appendix A Table A.2-73. The OSRA model estimates a 1-2% chance of one or more large oil spills occurring and contacting subsistence specific ERAs 3 (SUA: Uelen/Russia), and ERA 4 (SUA: Naukan/Russia). ERAs 5 (SUA: Shishmaref, North), and 13 (Kotzebue Sound) have a <0.5% occurrence and contact. ERA 41 (SUA: Barrow-Chukchi) has a 1-1% and 42 (SUA: Barrow- East Arch) has a 3-4% chance of occurrence and contact within 30 or 360 days over the Scenario. The OSRA model estimates the chance of one or more large spills occurring and contacting is 3-4% for ERA 38 (SUA: Point Hope-Cape Lisburne), 12-13% for ERA 39 (SUA: Point Lay-Kasegaluk), and 24-26% for ERA 40 (SUA: Icy Cape-Wainwright) within 30 or 360 days, respectively.

The OSRA model estimates the chance of one or more large oil spills occurring and contacting within 30 and 360 days, respectively as follows:

- LSs 72-76 (Point Lay) 1-1%
- LSs 64-66 (Point Hope) <0.5-2%
- LSs 73-82 (Wainwright) <0.5-3%
- LSs 80-85 (Barrow) <0.5-4%

The potential for bowhead whales and other marine mammals to be contacted directly from an oil spill under Alternative IV is relatively small, except in areas off Point Lay and Wainwright; however, the potential chance of contact to whale habitat, whale-migration corridors, and subsistence whaling areas in the Chukchi Sea (both Russian and American waters) is considerably greater. Onshore areas and terrestrial subsistence resources would have a lower potential for oil-spill occurrence and contact from this Alternative.

Effects from a Large Oil Spill on Subsistence-Harvest Patterns

The effects from a large oil spill on subsistence-harvest patterns is analyzed in the 2007 FEIS IV.C.1.1(1)(b)3). For more in-depth discussion of the biological effects to subsistence-harvest patterns from a large oil spill see Sections 4.3.5, 4.3.6, 4.3.7, and 4.3.8.

Bowhead and Beluga Whales - In the event of a large oil spill, the probability of oil contacting whales is considerably less than the probability of oil contacting bowhead or beluga habitat and hunting areas. If a spill occurred and contacted bowhead or beluga whale habitat during the fall migration, it is likely that some whales would be contacted by oil. It is likely that some whales would experience temporary, nonlethal effects from the oiling of skin, inhaling hydrocarbon vapors, ingesting contaminated prey, fouling of baleen, loss of food sources, and temporary displacement from some feeding areas. Oil-spill-response activities (including active attempts to move whales away from oiled areas) could cause short-term changes in local distribution and abundance. The effects from a large oil spill would result in a loss or curtailing of traditional practices for harvesting, sharing, and processing subsistence resources in the short term if concerns over the tainting of bowhead and beluga whales arise, if feeding areas from an oil spill are contaminated, or hunters are unable to use traditional hunting areas. This could be significant to the subsistence harvest of bowhead and beluga whales.

Whales, Seals, Other Marine Mammals, and Fish - For walrus, an oil spill impacting haulout areas could have a significant impact on the walrus population, although the chance of contact to haulout areas is small. Effects on seals from a large oil spill in nearshore marine or coastal riverine environments could cause injury or death to these sea mammals, potentially causing them to move off of their normal course, and make them unavailable for subsistence harvest. Seals—primarily bearded seals—are the most frequently harvested marine mammal in Wainwright and Point Lay. Wainwright hunts these seals between Icy Cape and Peard Bay (LS 74-81), which is the area where PL 9 may come onshore, connecting with the pump station. A large oil spill could have significant effects on the harvest of this resource. Oil-spill effects on seals could cause injury or death, or potentially cause them to move off of their normal course, making them unavailable for subsistence harvests. For polar bears, an offshore oil spill would produce a significant impact if areas in and around polar bear habitats were oiled. The resulting impact to polar bears could be alterations in population numbers due to their low reproductive rate. This would make them more difficult to harvest by the communities. A large oil spill impacting habitats used by fish could result in significant impacts to some local populations. Depending on the timing, extent, and persistence of a large spill, some distinct runs of pink and chum salmon could be eliminated. A large oil spill and the resulting effects would potentially make fish unavailable for subsistence harvest use for many seasons.

Caribou and Terrestrial Mammals - Caribou can frequent barrier islands and shallow coastal waters during periods of heavy insect harassment. As caribou visit these areas, a large oil spill could cause them to become oiled or ingest contaminated vegetation. During late winter-spring, caribou move out onto the ice to lick sea ice for the salt and could be exposed to oil after a spill. Caribou that become oiled are likely to become contaminated although toxic hydrocarbons absorbed through the skin or inhaled. Similar effects and results of oil contamination would be expected for muskoxen. Grizzly bears depend on coastal streams, beaches, mudflats, and river deltas during the summer and fall for catching fish and finding food. If an oil spill contaminates beaches and tidal flats along the Chukchi Sea coast, some grizzly bears and arctic foxes are likely to ingest contaminated food; ingestion could result in kidney failure and other complications. Contamination, actual or perceived, would contribute to tainting concerns, make subsistence harvesting more difficult, or making resources unavailable due to community concerns.

Birds - The greatest potential for substantial impacts on marine and coastal birds typically would come from large oil spills in important coastal bird habitats. Areas important to the subsistence harvest of birds are located near Peard Bay and near the Inaru and Mead River for Barrow, Akoliakatat Pass to Point Franklin for Wainwright, Naokok Pass for Point Lay, and at Cape Lisburne and Cape Thompson for Point Hope. 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, given the wide variety of possible ice conditions. A loss of subsistence bird species from an oil spill due to contamination or tainting could make this resource unavailable for subsistence use.

Far East Russia Communities - Potentially, important coastal lagoons and nearshore subsistence harvest areas for gray whale, the most culturally important resource for this region, beluga and bowhead whales, walruses, seals, fish, and birds could be contacted in the event of a large oil spill. Native Chukotka people have a traditional reliance on hunting and harvesting of marine resources with a large portion of their diet supplemented with traditional and other locally harvested resources such as domesticated reindeer. Effects from a large oil spill could exacerbate existing cultural and economic stressors on local resource populations and local hunting, causing significant impacts to Russian Native coastal communities (Newell, 2004; Nuttall, 2005).

Subsistence Practices – Subsistence practice would be affected if there was a reduction in subsistence resource populations or if availability of a subsistence species became limited, or contamination of a subsistence resource were to occur, causing tainting concerns and rendering a resource unfit to eat. The effects of these reduction and alterations could reduce the amount of subsistence foods harvested, causing changes in traditional diets and increased health risks, and create more cost to hunters due to wear and tear on equipment if hunters travel farther to obtain subsistence resources.

As an oil spill occurs, it may affect any part of the migration route of bowhead or beluga whales or other marine mammals, tainting resources that are culturally pivotal to the subsistence way of life. Even if whales were available for spring and fall hunts, tainting concerns could leave bowheads less desirable and alter or stop the subsistence hunt altogether. Communities unaffected by a potential spill would share these impacts to bowhead or beluga whale products. Unaffected villages could continue the harvesting, sharing, and processing of uncontaminated resources with those villages that are affected by a large oil spill. Oiling of resources, their habitats, and traditional hunting areas would cause a decline in harvests and an inability to access hunting. This decline and inability to access areas would be due to these areas being placed off limits during oil-spill cleanup activities. With limited or no access to hunting use areas, the gathering of resources would decline and thus community health concerns and stressors would increase (see Section 4.3.13).

Spill cleanup strategies could reduce the amount of spilled oil in the environment. Disturbance to bowhead and beluga whales, seals, walruses, polar bears, caribou, fish, and birds would increase from oil-spill-cleanup activities during breakup or during the open-water season. Offshore cleanup could cause whales to temporarily alter migration pathways. 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 mi (1.6 km) of the activity. Offshore presence of people and boats and onshore presence of people, support vehicles, and heavy equipment, as well as 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. Deflection of resources, resulting from the combination of a large oil spill and spill response activities, would persist beyond the timeframe of a single season, perhaps lasting several years.

Subsistence hunting would also be impacted by any spill response that required the local knowledge, experience, and vessels of local whaling captains. Diverting effort and equipment to oil-spill cleanup would impact the subsistence whale hunt (and other harvesting activities). Thus, oil-spill cleanup activities can be viewed as an additional impact, potentially causing displacement of the subsistence hunt and subsistence-harvest patterns. The overall result would be a major effect on subsistence harvests and subsistence users, who would suffer impacts to their nutritional and cultural well-being. Impacts subsistence harvests and subsistence users would be significant if they persisted for more than a single harvest season (Impact Assessment, Inc., 1998; USDOI, MMS, 2003, USDOI, BLM, 2004).

Mitigation Measures

Coordinate with subsistence users and user groups such as the AEWC on time and location restrictions to avoid interfereing with subsistence use activities.

A rapid response is key to mitigating impacts. Mitigation and monitoring would involve documentation of the human dimension, including consultation with subsistence hunters and appropriate organizations at the local and regional levels (i.e. Subsistence Advisory Committees, NSB Department of Wildlife, AEWC) entities, monitoring subsistence practices and assessing the social and economic aspects of the spill and effects of any litigation and settlement. Mitigation measures would include officials conducting community meetings to share findings regarding any information pertaining to contamination of subsistence resources, or the lack of contamination. For example, it was suggested the mouths of rivers be protected, perhaps with booms, to reduce impacts to fish and riparian habitat used by subsistence species (Public Hearing for Lease Sale 193 Remand - Chukchi Sea Barrow Alaska Taken December 3, 2014; pg. 79, line 9, Testimony of Craig George). As another example, after the *Selendang Ayu* incident, Alaska Native residents in Unalaska avoided harvesting shellfish in the bay where the ship had grounded because of concerns about contamination. Avoidance was practiced even after tests conducted by the State of Alaska Department of Health and Social Services, Section of Epidemiology determined that the shellfish were safe for human consumption (Impact Assessment, Inc., 2011a: 49). Thus, one way to mitigate impacts is to dispel and allay fears that specific subsistence resources might be contaminated. This would prevent unnecessary avoidance by consumers of subsistence foods.

Another mitigation measure is for flights to maintain an altitude of 1,500 feet and follow a flight path designed to avoid marine subsistence areas, (i.e. north of Point Franklin and no travel south of Point Franklin) during the northward migration of bowhead and beluga whales and the associated whale hunts. Further mitigation would be to attempt to time flights to avoid times of peak subsistence harvest. It could be helpful for flights to routinely head northwest in an arc to avoid the key subsistence harvest area offshore of Wainwright if the production base is constructed at Point Belcher, or from Icy Cape southeast in an arc to avoid Wainwright's key offshore subsistence area if the production base is constructed at Icy Cape. If these mitigation measures are not followed, the level of effects would elevate from moderate to major.

Conclusion

This phase involves the same activities as the exploration and development phases, but adds long-terms effects from platform installation, cleanup crew presence and operations, as well as pipeline maintenance and large oil spills. Effects from large oil spills or disturbance/displacement along the 300 mi (483 km) onshore pipeline route would persist across seasons. This is not anticipated to impact any one species to a population-level effect. However, large spills could affect subsistence patterns by reducing populations or availability of a subsistence-harvest resource, contaminating subsistence resource habitats, creating a perception of tainting and tainting concerns, and rendering resources unfit to eat. These effects could reduce the amount of subsistence foods harvested, cause changes in traditional diets, and increase risks along with wear and tear on equipment if users travel farther to obtain subsistence resources. Should any resource population decline, the potential impact to communities who rely on subsistence would be severe. Overall, the activities conducted during this time period are anticipated to have a major impact on subsistence-harvest patterns since the subsistence resources could become undesirable or potentially reduced in numbers, making them unavailable.

Development and Production (Years 26-50)

Development and production activities during this period would continue in roughly the same manner and frequency as during the preceding phases analyzed above. This phase includes seismic surveys, construction of a satellite field, and continuation of oil production. Construction activities would include installation of two additional production platforms and several offshore pipelines in Years 27-30. A gas pipeline—both offshore and onshore—would be constructed. The construction and installation of these gas pipelines would be the same as described earlier. These new gas pipelines would be installed running parallel to the oil pipelines.

Noise and disturbance impacts to subsistence-harvest resources would be similar to those analyzed in earlier sections, although there could be a total of up to 48 helicopter flights daily, as eight platforms will be operational. The effects of helicopter overflights on marine harvesters, described previously, would increase. There would be temporary, localized effects on offshore habitats from construction and placement of gas pipelines, including suspension of sediments during offshore gas pipeline construction and placement, but these effects would not persist across seasons. Effects could be reduced to minor to moderate levels if the first 40 miles of gas pipelines were constructed during the winter months, and in collaboration with marine subsistence harvesters, the Wainwright Whaling Captains' Association, and the AEWC to coordinate suspension of activity to minimize effects on the spring bowhead whale migration. Construction of an onshore gas pipeline would result in effects to terrestrial mammals used for subsistence. The installation of this pipeline adjacent to or buried near the oil pipeline could minimize effects to resources. Long-term access and maintenance could displace some terrestrial subsistence resources along this corridor.

Small spills (<1,000 bbl) and large (≥1,000 bbl) spills could occur during development and production. Two large spills are assumed to occur during the entire life of development and production. These spills are analyzed in Years 10-25; impacts would be the same in this phase. The development and production of sales gas in Year 31 raises the potential for dry gas releases. Gas releases could occur during development and production. Up to three gas releases were considered—one from a platform and two from an onshore pipeline.

Gas releases (with or without explosion hazards in confined spaces) could occur. This analysis estimates one 10 million cubic foot release occurs offshore from the facility and two 20 million cubic feet releases occur onshore from the 300 mi (483 km) gas pipeline. An accident involving an ocean-bottom well-control device failure or undersea gas transport pipeline release would be short term (up to one day). Effects to baleen whale prey would be negligible considering the low volume, short duration, rapid dissipation, and localized nature of a release. A temporary disruption of the spring migration of bowhead whales and beluga whales through the spring polynya system or spring lead system is possible if release/explosion/control activities occurred during the migration period. Short-term, non-lethal avoidance of activity or startle behavior in response to an explosion or short-term release would be expected. Impacts to polar bears would be minimal since gas quickly dissipates in the atmosphere and any potential impacts could be felt by a bear in the immediate vicinity of a release. Any impacts would come from animals 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. Physical effects to fish subsistence resources from a natural gas release described in the Scenario would be negligible. No 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. For terrestrial mammals used for subsistence, a natural gas release is also of minor concern. The distance between any of the Leased Areas and the coast is such that it is extremely unlikely that gas released could contact the coast. Natural gas will weather and dissipate quickly in the atmosphere, preventing widespread effects. 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.

Mitigation Measures

Mitigation measures would include those described throughout this section, and for previous periods of development.

Conclusion

This phase involves the same activities as the exploration and development phase, but at a slightly reduced level because only two platforms would be constructed, there would be no drilling of exploration or delineation wells, and no additional exploration platforms would be emplaced. Effects from disturbance/displacement along the 300 mi (483 km) oil/gas pipeline route would persist across seasons. The deferral areas incorporated into Alternative III could increase the distance of a potential release from the platform to areas of subsistence resource use such as bowhead or beluga whale habitat. 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 longer pipeline. Overall, the activities conducted during this time period are anticipated to have a moderate impact to subsistence-harvest patterns as certain development activities are reduced.

Production and Decommissioning (Years 51-77)

Production activities will have become routine as oil production shifts to gas production. No additional construction or seismic survey activities are anticipated. Production platforms would remain obstacles to marine mammals used as subsistence resources until the removal of these platforms, beginning in Year 60. There is an extended period (Years 54-65) of additional drill rig activity and this activity may increase effects to subsistence-harvest patterns. After both oil and gas resources are depleted, facilities would begin to shutdown, wells would be plugged, and processing modules would be moved off the platforms. Decommissioning activities include: plugging wells, decommissioning subsea pipelines, and removal of production equipment and platforms. These activities are potential sources of noise, disturbance, and possible injury to subsistence species. The use of explosives during these activities could result in injury or even death to marine mammals used as subsistence-harvest resources if they are present in the area at the time of the detonations. Impacts to bowhead and beluga whales from well-decommissioning activities may be avoided if these activities are conducted after whales completed their migration through the area. Decommissioning of pipelines would occur during this phase. They would be flushed and cleaned, usually left in place, and then buried below the seafloor surface. Production equipment would be partly disassembled and then moved off the platform during the summer open-water season. This could affect subsistence-harvest resources due to impacts described in the previous sections. Further, decommissioning activities could impact open-water subsistence hunts by causing deflection of resources or by making resources unavailable for harvest.

Small (<1,000 bbl) and large (≥1,000 bbl) crude, condensate or diesel spills could occur until Year 53, when crude oil and natural gas liquid condensate production ends. Large diesel spills and gas releases could occur through Year 74. Refined small spills could occur through Year 77. Effects from these spills on subsistence-harvest patterns and access to hunting areas would experience the same impacts as analyzed in Years 1-5, 10-25 and 26-50.

Mitigation Measures

Mitigation measures would include those described throughout this section and for previous periods of development.

Conclusion

This time period involves the same activities as the previous phase, but there would be no additional construction and drilling activity is intensified at the mid-point. Platforms would gradually be removed. Long-term effects from platform and pipeline operation/maintenance would continue, but at a reduced level. Effects from disturbance/displacement along the 300 mi (483 km) oil/gas pipeline route would persist, but at a reduced level. Overall, the activities conducted during this time period are anticipated to have minor to moderate impacts to subsistence harvest resources. The level of impacts could decrease if industry implements the mitigation and avoidance as measures as previously described. There would be a low potential for decommissioning activities to disrupt subsistence activities offshore of Wainwright for a substantial portion of a subsistence season.

Conclusion for Alternatives I and IV

Over the life of the Scenario several impact producing factors could affect subsistence. Many of these (vessel/drilling/aircraft noise, physical presence, habitat alteration, and discharges) would have moderate to major levels of effects, unless mitigation measures are followed, including avoidance, because these activities can cause impacts to the resources themselves (deflection, alteration of migration patterns). This in turn disrupts subsistence hunts by causing some subsistence resources to avoid traditional hunting areas or to travel farther from shore, making hunts more difficult because subsistence species would be available in potentially reduced numbers. Resources could even be unavailable for use for a substantial portion of a subsistence season for Wainwright and possibly Atqasuk. Periods of construction activity would have a localized, short-term effect on resources; however, the footprints of some facilities in the terrestrial environment could result in permanent alterations or a loss of habitat for terrestrial subsistence-harvest patterns, resulting in potentially reduced numbers of subsistence species available, or simply unavailable for a substantial portion of a subsistence season for Wainwright and possibly Atqasuk. Long term operation of pipelines necessitates access along the route, which brings disturbance that could displace resources away from the pipeline corridor or damage subsistence areas with plants and berries. If the mitigation measures described throughout the subsistence section of this document are followed, the level of effects could be reduced to minor to moderate.

The greatest amount of disruption to subsistence-harvest patterns could come from large oil spills. Contact from oil could cause actual or perceived tainting, resulting in the resource becoming unavailable or undesirable for use for the substantial part of one or more subsistence seasons. If this occurs, the impact to subsistence would be major.

Anticipated impacts to subsistence and on the cultural practice of subsistence hunting from the Scenario range from minor to major during Exploration (Years 1-5) and moderate to major during Exploration and Development (Years 6-9) and Production and Decommissioning (Years 51-77). The phases with the most overlapping activities and highest probability of spills causing impacts to subsistence-harvest patterns are during Exploration, Development, and Production (Years 10-25) and during Development and Production (Years 26-50). Once exploration drilling ceases, impacts are reduced, with lower levels of effects. The potential level of impacts to subsistence, in combination with disruptions to subsistence hunts (due to alterations of resources and use areas and perceptions of tainting resulting in an unavailability of traditional subsistence resources) could result in a major impact on subsistence-harvest resources. However, incorporating the above noted mitigation measures, including avoidance to reduce conflict with subsistence activities, has the potential to reduce the level of effects from major to moderate, or even minor, if coordination between industry and subsistence users is diligent.

4.3.11.2. Alternative II – No Action

Under Alternative II, Lease Sale 193 would not be affirmed and no current leases would be available for further exploratory drilling or other oil and gas development. Impacts from the Scenario on subsistence-harvest patterns from possible disruption due to noise, physical presence, and real or perceived contamination associated with the development of offshore oil and gas resources, and the construction of land-based facilities needed to support exploration and subsequent production would not occur. Consequently, selection of Alternative II would result in negligible impact to subsistence-harvest patterns.

4.3.11.3. Alternative III – Corridor I Deferral

Alternative III provides the largest deferral area of the action alternatives – a corridor approximately 60 miles (97 km) wide along the Chukchi Sea shoreline. If Alternative III were selected, the distance from the shore to many activities could be greater than under Alternatives I and IV. No exploration or development drilling or platform construction would occur within the corridor, although certain activities (i.e., installation of a pipeline extending from the leases outside the corridor to the shore) could occur there. Of the Lease Sale 193 leases, only five are within Corridor I.

The minimum distance from shore under Alternative III could be slightly greater for the following than under the other action alternatives: length of pipeline from a platform to shore; travel distances from vessels and aircraft; source of discharges, emissions and noise from drilling and platforms; and, the source of a large offshore oil spill from a platform.

The primary benefit of the corridor provided by Alternative III is that it would move potential sources of adverse effects farther away from subsistence activities. This alternative would potentially reduce sources of noise and disturbance on subsistence resources, subsistence whaling and other marine mammal hunting. The increased distance between offshore development and the shore could decrease the likelihood of spilled oil contacting subsistence resources and harvest activities; increase weathering of spilled oil prior to contacting subsistence resources; and increase the time to mount an oil-spill response. As a result, the impacts of Alternative III on marine subsistence could be slightly less than the impacts under the other action alternatives. Using the Impacts Scale in Section 4.2, the level of impacts under Alternative III would be consistent with the other action alternatives.

4.3.12. Sociocultural Systems

This section describes the potential effects on sociocultural systems from activities associated with the Proposed Action as described in the Scenario. Sociocultural systems are analyzed with reference to three key structuring elements: social organization, cultural values, and institutional formation.

Social organization corresponds most closely to existing structure at the household and community level that manages vital resources, which includes subsistence harvest but also encompasses all manner of economic resources involving the broader cash economy. The analytic focus here is on households, families, and wider networks of kinship and friends that, in turn, are embedded in groups that are responsible for acquiring, distributing, and consuming available local resources. In many ways, this element describes the nongovernmental characteristics of the community. Potential effects to social organization could be realized if project-related activities disrupt subsistence activities, change the demographics of the area, alter employment or income characteristics of the area, or otherwise affect the social well-being of local residents.

Cultural values correspond to the Inupiat traditional emphasis on maintaining a close relationship with natural resources, with particular focus on kinship, maintenance of the community, cooperation, and sharing. Subsistence is a central activity that embodies these values, with bowhead whale hunting the paramount subsistence activity. Potential effects to cultural values could be realized if project-related activities alter subsistence harvest, erode known archaeological or cultural sites, or alter processes that maintain cultural continuity. This element overlaps closely with both social organization and institutional formation.

Institutional formation corresponds primarily to the structure and functions of borough, city, and tribal government, and related formal organizations such the Alaska Native Regional and various village for-profit and not-for-profit corporations, and nongovernmental organizations. Potential effects to institutional formation could be realized if project-related activities affect how institutions are structured or how they function to provide services and foster community well-being or serve to maintain cultural preferences. These community structures and institutions are formed in large measure by Alaska Natives who live with a consciousness of traditional knowledge and present day awareness of their own cultural foundations and precepts.

Through any of these key structuring elements, the existing sociocultural system can be affected in a negative manner if the primary foundation of the system ─ subsistence harvest, sharing, and consumption practices ─ become significantly disrupted. Likewise, the sociocultural system can be variously affected in either a positive or negative manner if regional economic revenue occurs on a scale sufficient to create substantial local changes in demography, employment, commodity pricing, or community prosperity (USDOI, MMS, 2006d; Picou et al., 2009). Therefore, the IPFs that affect subsistence-harvest patterns as described in Section 4.3.11 are relevant here, as well as the potential regional economic effects that could potentially follow from the Scenario as described in Section 4.3.10. In characterizing the potential adverse effects from OCS activities, this section considers the magnitude and duration of disruption, with a significance threshold for "moderate" impacts defined as a chronic disruption of social organization, cultural values, and/or institutional formation for a period greater than one year, with a tendency toward displacement of existing social patterns. "Major" impacts are defined as chronic disruption for a period greater than one year with tendency toward extensive and sustained displacement of existing social patterns.

4.3.12.1. Alternatives I and IV

Sociocultural systems have the potential to be impacted by the Scenario through: (1) disruptions to the social organization and/or institutional formation of communities, (2) disruptions to cultural and social values, and (3) disruptions to the economy of households and the community as a whole. The Leased Area is no closer to shore than 60 miles. However, many Scenario activities have potential to impact the sociocultural systems of the North Slope. Most notably, the effects of oil and gas activities may impact subsistence-harvest resources. Harvest loss, if sustained, could result in disruption to food sharing patterns or cultural resources, creating cultural stress and diminished nutritional status for some portion of the community. This in turn can erode or damage community cultural values and create stress on local institutions such as health care delivery systems. As analyzed in Section 4.3.11, if detectable impacts to subsistence-harvest patterns were to occur, the highest potential for change would be in the community of Wainwright, with likely impacts also reaching to Point Lay, Point Hope, and Barrow. As analyzed in Section 4.3.10, if substantial economic effects were to materialize over the course of the Scenario, then the potential for chronic displacement of sociocultural patterns may expand to all communities of the North Slope Borough.

4.3.12.1.1. Impact Producing Factors

This section identifies IPFs associated with the Scenario that have the potential to affect sociocultural systems. Each IPF is organized by phase of oil and gas activity (i.e. exploration, development, production, and decommissioning) and IPFs which occur during multiple phases are addressed in the phase in which they first appear. Since sociocultural systems are prone to impact by disruptions to subsistence activities, the IPFs analyzed here are similar to the IPFs analyzed for Subsistence-Harvest Patterns in Section 4.3.11. The primary categories of IPFs affecting sociocultural systems are noise, physical presence, discharges, habitat alteration, and accidental oil spills. Since sociocultural systems are also prone to impacts from substantial changes in economic activity and revenue streams that could begin during the Development and Production phase, the IPFs analyzed here will also encompass potential changes in employment, demographics, property tax revenues, and community services (as described in Section 4.3.10), with corresponding implications for social organization, cultural values, and institutional formation. For each phase below, particular activities leading to these IPFs are first described, and then the ways in which the activities could produce impacts on sociocultural systems are explained.

Accidental spills, though not considered routine oil and gas activities, have the potential to occur during each phase of the Scenario. General impacts of small and large oil spills and gas releases are addressed as IPFs in the subsection where they have the potential to occur. The impacts of oil spills and gas releases within the larger context of all other activities that occur during each period are analyzed below in the "Impacts of the Scenario Through Time."

Exploration

The activities associated with the exploration phase that have the potential to impact sociocultural systems are the same as the IPFs for subsistence. These activities are: vessel-based marine surveys, vessel and aircraft support, exploration and delineation well drilling, mobile platform placement, shorebase construction, pipeline construction, and onshore road construction. Rather than repeat prior analysis, this section will focus on new or additional considerations that have not been previously discussed in Section 4.3.11.

Noise

Marine Vessels: For marine seismic surveys, geohazard surveys, and OCS exploration activities, effects to sociocultural systems are expected not to exceed the significance threshold. Because the seismic-survey activities are vessel based, stresses to local village infrastructure, health care, and emergency response systems are expected to be minimal; therefore, social systems in these communities would experience little direct disturbance from the staging of personnel and equipment for seismic exploration. Community levels of anxiety are likely to increase somewhat primarily because of ongoing hunter concerns over seaward deflection of bowhead whales from increased underwater noise propagation. These concerns may translate into greater expenditure of hunter effort, such as more preparation, extended search effort, more costly logistical investments, and more time in meetings as various institutions seek to reduce risk and influence the decision making process.

Aircraft: The same analysis also applies for potential aircraft noise sources as analyzed in Section 4.3.11.

Drilling: Effects of drilling noise on sociocultural systems are the same as those analyzed for seismic noise and in Section 4.3.11.

Construction: The types of construction noise sources are analyzed in Section 4.3.11 and remain the same for this analysis. Potential direct effects to subsistence-harvest patterns would be mostly localized and short term. Such disruptions could indirectly affect the sociocultural systems of the North Slope.

Physical Presence

Impacts from physical presence, as analyzed in Section 4.3.11, can occur either from increased marine or aircraft traffic, newly erected man-made structures or work camps, or as a consequence of increased social presence and human interaction with outsiders in small communities.

Vessels: Increasing vessel presence would occur with oil and gas activities, and increasing vessel traffic for other reasons, such as shipping and tourism, can affect sociocultural systems. During exploration, seismic vessels would be present during the open-water season and would make periodic trips (once every two weeks) to Wainwright. During exploration drilling, vessel presence could increase to Wainwright or to the location of the newly constructed shorebase, and trips could increase to a frequency of 1-3 trips per week. During this phase, helicopters would be used during exploration drilling to support operations. These flights would occur at a frequency of 1-3 flights per day from Wainwright. The increased physical and social presence in the region has the potential to deflect subsistence resources, increase new employment and transitory presence, and may provide a modest stimulus to economic growth in the region.

Shorebase Operations: An increase in the presence of field crews and oil workers who could conduct construction and land-based operations has the potential to affect sociocultural systems. Disturbances by field crews and oil workers to subsistence-harvest patterns as analyzed in Section 4.3.11 could occur due to the disturbance of resource habitats by increased pedestrian traffic, driving equipment or vehicles into these areas, and through an increased presence of human voices and activity.

At the local level, Wainwright may experience significant effects at this phase. Noticeable disruption would most likely result from the construction of onshore infrastructure, with the most visible effect being the change in land use that comes about by introduction of industrialization. However, Wainwright would also likely experience moderate effects on social organization, cultural values, and institutional formation for a period exceeding one year. For example, construction would create business opportunities for Native corporations. Modest local employment would help stabilize population growth and community vitality over the short term. The end of shorebase construction could cause an exodus of workers, but as noted elsewhere, petroleum activities generally have not translated into substantial employment opportunities for Alaska Native residents. Nonetheless, employment opportunities are viewed positively by Borough residents, and wage employment can facilitate subsistence harvest activities.

At the regional level, shorebase construction and operations are unlikely to displace existing social patterns at a level of Major. This infrastructure represents a continuation of the dominant industrial/commercial activity on the Borough level. Some local services could be affected by the proximity of operations to Wainwright. Conflicts over subsistence resources are not expected as non-

Native households of NSB communities claim to use none or very little subsistence resources (Shepro, Maas, and Callaway, 2003).

Discharges

There are several types of discharges that can occur during exploration. Discharges from exploration operations in the Chukchi Sea are permitted under an NPDES General Permits that are issued by the EPA and have a term of five years. Discharges under a General Permit for exploration typically include sanitary waste, domestic waste, drilling fluids, drilling cuttings, and deck drainage. Details on discharges of drilling wastes including cuttings and muds are addressed under Water Quality in Alternatives I and IV Section 4.3.1, Exploration subsection, Discharges sub-subsection, and in 4.3.7.Marine Mammals, Alternatives I and IV, Exploration subsection, Discharges sub-subsection.

Sources and discharge released during exploration can be due to: discharge of water-based drilling muds and drill cuttings, and discharges of graywater from crew use areas (galleys, bathrooms, etc.). Although illegal, there may also be releases of sludge, garbage, or other debris from vessels which could pose risks to wildlife and subsistence-harvest patterns.

Discharges have the potential to affect sociocultural systems by contaminating water and food that subsistence resources and community members utilize. Institutional organizations of the North Slope have been especially concerned about offshore discharges, and in 2011, leadership passed Resolution 11-28 expressing concern about the potential effects discharge could have on the environment and subsistence-harvest patterns, which in turn, if substantial enough, could affect sociocultural systems.

However, discharge effects to sociocultural systems under the Scenario analyzed here are expected not to exceed the significance threshold. It is possible that drilling muds and cuttings may be reinjected into exploration service wells. If so, very little turbidity would result and potential effects from discharge would not likely be sufficient to displace existing social patterns at the local or regional level. Ongoing long-term monitoring of benthos, sediment chemistry, and food web processes in the Leased Area will provide additional mitigation to help detect and safeguard against unhealthy concentrations of industrial metals, hydrocarbons, and other contaminants (e.g. BOEM OCS Study Number 2012-012; Hanna Shoal Ecosystem Study Cruise Report 2013).

Accidental Oil Spills

Small Refined Spills (<1,000 bbl), although accidental, generally are routine, expected, and have the potential to occur during exploration activities. Small spills may be contained on a vessel or platform, or those spills reaching the water may be contained by booms or absorbent pads. Small refined spills can occur from: vessel spills, leaking connections, ruptured lines and seal failures, or human error while refueling.

Small refined spills are primarily aviation fuel, diesel fuel, engine lube, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil. In water, ambient hydrocarbon concentrations of small refined spills would persist for a shorter time than crude oil spill of the same volume. The impacts to sociocultural systems from small refined oil spills may include disruptions to institutional processes and to cultural values. For example, during exploration drilling, accidental oil spills could affect the aesthetic, cultural and spiritual values of North Slope communities by damaging subsistence-harvest patterns or creating a perception of contamination. Contamination, or perceived contamination, can result in an inability to share the results of harvests within the community and with relatives and other community members located outside of the community.

During exploration, a refueling barge may be anchored in Kotzebue Sound. This barge would be moored in the sound, and small spills of 50 bbl or less could occur. There is a potential for a spill during fuel transfers between vessels, and a fuel spill would potentially introduce hydrocarbons to the water that affect fish and marine mammals used for subsistence. However, it is anticipated that such a spill would be localized and short-lived due to volatilization of light hydrocarbons.

Development

Development is the construction of facilities to produce hydrocarbons and move them to market. Many of the same IPFs that could arise from development activities were described for the exploration phase, and are not repeated here. Only new activities associated with the IPFs are described below. New activities which can affect sociocultural systems during this phase include: installation of offshore production platforms and installation of onshore oil and gas pipelines.

The impacts associated with development activities include: Noise, Physical Presence, Discharges, Habitat Alteration, and Accidental Oil Spills. The notable IPF of potential economic revenue is added during this phase of analysis.

Noise

The potential effects of noise from drilling wells for oil and gas production would be similar to that previously described for drilling exploration wells. New construction noise in this phase could come from: platform construction (OCS), pile driving (offshore), pipeline installation (offshore and onshore), and new road and production base construction (onshore).

Impacts to sociocultural systems would be similar but additive to those impacts previously described under exploration and in Section 4.3.11. Level of effects would be expected to remain minor.

Physical Presence

The installation of platforms and offshore pipelines would increase the number of vessels/barges operating in the marine environment, especially the near shore environment. These vessels would be anticipated to have similar effects as regular support vessels, but the presence of cranes or larger superstructures could increase activities at the shorebase facility near Wainwright. Effects of physical presence on sociocultural systems would be similar but additive to those in the exploration phase.

Discharges

The installation of OCS platforms and both offshore and onshore pipelines would increase the number of vessels/barges operating in the marine environment. Discharges of graywater and ballast water from these vessels would remain regulated by the same permit authority as previously described under the exploration phase.

Habitat Alteration

The installation of platforms and pipelines would increase the amount of habitat disturbance or modification in the marine and terrestrial environments, and the installation of pipelines across the terrestrial environment could permanently affect habitats where pipelines are located. These alterations from construction activities affect subsistence-harvest patterns as analyzed in Section 4.3.11.

The effects to sociocultural systems from habitat alterations are related primarily to the potential loss of subsistence resources and decreased harvests, and potential inability to hunt. Habitat alteration is an ongoing feature of the existing environment on the North Slope, and so increments of change driven by new construction in the vicinity of Wainwright would likely involve localized effects.

Accidental Oil Spills and Gas Releases

In addition to small refined spills analyzed under exploration, development activities contribute to the potential for small oil spills or gas releases. In the event of a small spill, subsistence harvest resources would be affected due to contact with crude or condensate, in addition to refined products, resulting in impacts to sociocultural systems. Small refined spills are possible during production activities as well as during development. The effects of small spills remain as previously described above.

Economic Revenue

As discussed in Section 4.3.10, several types of revenue stream would occur with development and potentially extend through production activities. The North Slope Borough and the State of Alaska would both receive a share of revenues from property taxes assessed for onshore oil and gas infrastructure. The State would also gain revenue from relevant corporate income tax and potential royalties from TAPS tariff due to OCS volumes. If the property tax revenue stream approaches the estimate of $3.3 billion for the NSB, then substantial changes, both positive and negative, could be triggered.

The breadth of social impacts which oil development revenue brought to the North Slope following the historic discovery at Prudhoe Bay on the Beaufort Sea coast provides a rough analog for the type of social impacts that could potentially be entrained by a major discovery and production scenario along the Chukchi Sea coast. Social indicator data collected from the NSB since 1970 (through the United States Census Bureau and other survey efforts) reveal a strong positive direction of several key social trends associated with oil development revenue following the discovery at Prudhoe Bay, including substantial growth in public services, population, employment, household income, and subsistence productivity (Northern Economics 2006). After North Slope leaders established a home-rule Borough in 1974 to optimize control by local self-government, the NSB began raising billions of dollars (~$7 billion since 1977) for capital projects by selling bonds that are retired through tax revenue from Prudhoe Bay properties. These capital improvement projects increased a wide range of new public services. For example, water and sanitation services increased from no service in 1970 to more than 75 percent of households by 2010. The number of housing units increased from about 500 to more than 2500, with notable improvements in construction quality. Health and social services increased such that life expectancy rose from age 46 to 67. The median number of years of public education for young adults changed from less than 4 to more than 12, and over time the NSB constructed 11 schools and established Ilisagvik College in Barrow. Satellite links have accelerated telecommunications while expanding airplane service and barge traffic have improved transport of goods and services. The majority of NSB residents hold positive views of increased prosperity and productivity made possible from oil revenues. These changes are generally interpreted as net benefits of development.

It is especially noteworthy that researchers have discovered a positive relationship on the North Slope between cash income and subsistence use, including capital investments in subsistence activities, magnitude of harvest levels and diversity of species harvested, as well as geographic range of food distribution networks. NSB residents have tended to allocate less time for subsistence as they increase employment time, creating a reduction in frequency or duration of hunting effort. Yet greater income allows for equipment purchases that promote more efficient use of time, such as GPS units, VHF radios, snowmachines, three-wheelers, motor boats, charter planes, and satellite imagery (Lonner, 1986; Jorgensen, 1990).

But accrued benefits from oil development revenue do not reveal the whole story. Many NSB residents living close to oil field infrastructure also remain concerned about perceived adverse effects from economic growth, which they assert include: displacement and disruption of wildlife, altered habitat with diminished wildlife stocks, threat of contamination, changes in traditional living, emergent social problems, and cumulative adverse effects (Braund, 2009b; Braund, 2013b). The novel topic to consider at this phase of the Scenario is the relationship between oil development revenue and emergent social problems. Following the experience of development at Prudhoe Bay and adjacent satellite fields, social research has documented that NSB residents do indeed perceive negative changes in traditional living. For example, some residents report that industrial sprawl diminishes their cultural sense of solitude and identity with the land. For example, hunters report that camps and other sites of cultural significance have been destroyed, looted, or rendered unappealing. In 2009, 13 percent of surveyed hunters in the community of Nuiqsut reported personal experiences with such negative impacts (Braund 2009b:13). Public burden associated with the expanded operations of government, industry, and science in small communities creates another arena of concern. But the topic which NSB residents most consistently express concerns about pertains to persistent social pathologies, especially substance abuse, domestic violence, and suicide. The magnitude of these social problems provides ample cause for concern, though they are notoriously difficult to quantify or to establish root causation.

Absent a major oil spill, social research has not found a means to isolate and measure direct community effects that might be conclusively attributed to oil development revenue streams apart from indirect effects that exist within the broader context of modernization and widespread technological change. For example, several studies have reported on the presence of NSB social dysfunctions that pre-exist the formal period of oil revenues (Worl 1979; Kruse 1984: 152-153). Conversely, other studies document an emergent social solidarity around key concerns within local communities that occurred in association with oil development. For example, the NSB has pioneered many innovative political and legal arrangements, including co-management partnerships that direct the use of natural resources and the creation of conflict avoidance agreements that mitigate oil development impacts. This perspective is reaffirmed by the recent international Survey of Living Conditions in the Arctic study, which revealed that Alaskan Inupiat consider themselves well off, and rank their living standards equal to or better than Native residents in any other oil producing region of the Arctic (Kruse et al. 2008).

For all these reasons, regional sociocultural impacts following new growth of substantial economic revenue would likely achieve major levels of effect, but a large percentage of those effects are expected to provide social benefit and would actually serve to sustain community subsistence activities. Only a relatively small percentage of those effects are expected to adversely diminish established standards of community well-being.

Production

The production phase features the production of hydrocarbons and gas throughout the life of the field. Many of the same IPFs that could arise from development activities were described for the exploration phase and those potential impacts are not repeated here.

Activities associated with production include vessel, aircraft, and vehicle traffic to operate/maintain facilities to produce hydrocarbons and move them to market. The same effects from those IPFs that could arise from production activities were described for exploration and development and are not repeated here. The effects remain as previously described above.

Noise

There are no new sources of noise associated with production phase.

Physical Presence

The presence of platforms and other supporting facilities would have an ongoing effect on sociocultural systems. Once a platform is constructed it would remain during the life of the field. The creation of permanent structures would trigger the need for deliberate avoidance in marine navigation, but the distance from shore should preclude direct implications for subsistence hunting. Support vessel traffic to a constructed platform would add physical presence that would require additional navigational concern and radio communication by offshore subsistence hunters. During this phase, vessel and aircraft activity could stabilize, along with the number of field crews and oil workers utilized for ongoing operation and maintenance of production facilities.

Discharges

There are no new sources of discharge associated with production phase that would cause impacts beyond what has been previously described.

Habitat Alteration

Activities on areas adjacent to facilities (e.g., shorebase, pipelines, and access roads) would have a potential ongoing effect of displacing terrestrial subsistence-harvest patterns, resulting in impacts to sociocultural systems as analyzed in Section 4.3.11. Additional bird strikes could occur offshore.

Accidental Oil Spills

Small or large oil spills or gas releases are possible during oil and gas production activities. Impacts to sociocultural systems from small spills are analyzed under exploration and development and do not change with production.

In the unlikely event of a large oil spill, noticeable social disruption over a period of years could occur. For example, traditional practices for harvesting, sharing, and processing subsistence resources could be seriously curtailed in the short term if there are concerns over contamination. Oil-spill employment (response and cleanup) could disrupt subsistence-harvest activities for at least an entire season and could further displace these systems. The sudden employment increase could have abnormally high effects, including inflation and displacement of Native residents from their normal subsistence-harvest activities. Cleanup employment of local Inupiat also could alter normal subsistence practices and put stresses on local village infrastructures by drawing local workers away from village service jobs.

Stress created by the perpetual fear of an oil spill is a distinct sociocultural impact that would be intensified in the event of an actual spill. Stress from this general fear would include component parts, such as anxiety over:

- Ecological damage that spills would cause to the present and future natural environment
- Contamination of subsistence foods
- Inundation by outsiders who could disrupt local cultural continuity
- Protracted oil-spill litigation and conflict
- Consumption of time and resources to interact with regional, State, and Federal agencies

Disruption of subsistence-harvest resources, such as that created by a large oil spill, would have predictable and significant consequences and would affect all aspects of sociocultural resources (Luton, 1985). The primary effect would be reduced food security and the depletion of household stored foods.

Social organization effects would be very pronounced. Social well-being would be affected as safety and health concerns dramatically intensified. Increased demands would be placed on the networks in which each household participates, as available resources were redistributed according to need. If scarcity continues, greater requests would be made, first to nearby communities and then to those beyond (Fairbanks, Anchorage, and other cities inside and outside Alaska). These requests, in turn, would accelerate the depletion of the resources of the contributing networks. Employment and income effects could be realized as cash was expended to purchase food at local stores to make up for the shortfall in harvested foods. Lines of credit would be stretched. Workforce changes and demographic changes could occur with consolidation of households to save money, placement of dependents with relatives beyond the village, and outmigration of wage earners in search of employment. These extreme circumstances could potentially reduce the stability of families and communities.

Stress to subsistence and sharing could affect the central core values of the Inupiat culture. The inability of the community's leaders—subsistence providers—to fulfill their role would have negative effects on community stability. Over time, if knowledge holders or recipients are removed from the community, spiritual teaching and knowledge transfer that takes place as part of the hunt would be diminished. The loss of equipment and property used in subsistence harvest or cultural expression and trade, a source of supplemental income to approximately one in five households, could also result. If a large spill contacted and extensively oiled coastal habitats, the presence of hundreds of humans, boats, and aircraft would displace subsistence species and alter or reduce access to these species by subsistence hunters. Employment generated to clean up an oil spill of 1,500 or 4,600 bbl could call for 60 or 190 cleanup workers. This rapid employment increase could have sudden and abnormally high effects, including inflation and displacement of Alaska Native residents from their normal subsistence-harvest activities by employing them as spill remediation workers.

Institutional structures 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. Cleanup is unlikely to add population to the communities, because administrators and workers would live in separate enclaves; cleanup employment of local Inupiat could alter normal subsistence practices and put stresses on local village infrastructures by drawing local workers away from village service job. Spill cleanup would reduce the amount of spilled oil in the environment and tend to mitigate spill effects. Nonetheless, oil-spill cleanup activities should be anticipated as an additional impact, causing displacement and employment disruptions, as well as extensive community discord (Picou et al. in MMS OCS Study Number 2009-006).

The collective effects of this level of disruption would last beyond the period of cleanup, and would represent a chronic disruption of social organization, cultural values, and institutions. The effects would have a tendency to displace existing social patterns and constitute moderate to major levels of impact.

Economic Revenue

Impacts to sociocultural systems from potentially substantial tax revenue are analyzed under Development, above, and do not change with production.

Impacts of the Scenario through Time

This section provides analysis of impacts to sociocultural systems as they occur through the 77 years of the Scenario. This analysis addresses the particular oil and gas activities that could occur during each relevant time period, and analyzes their impacts against the backdrop of a dynamic affected environment. Whereas previous sections have focused on identifying relevant IPFs and the types of environmental impacts they may cause, this section more specifically accounts for the level at which each IPF occurs during a given phase, the overlap of IPFs, and any additive or synergistic impacts which may result.

Many of the impacts through time to subsistence-harvest patterns analyzed in Section 4.3.11 drive sociocultural system impacts, and will be referenced in this section as needed.

Exploration (Years 1-5)

During Years 1-5, the activities anticipated include: OCS seismic surveys, OCS exploration and delineation drilling operations, and onshore construction activities that include an exploration base, supply boat terminal, air support base, and a search and rescue (SAR) base.

During each of these years, deep penetration seismic surveys would occur and could involve as many as three vessels during the open-water season (July-November). Surveys conducted during other time periods, such as in-ice surveys (December) would occur. An open-water season, seismic survey operation in the Chukchi Sea was analyzed in the 2013 TGS 2D Geological and Geophysical Seismic Survey EA (USDOI, BOEM, 2013a). For that survey, activities and anticipated impacts included noise, disturbance, and a small fuel spill.

Geohazard and geotechnical surveys are typically conducted in association with exploration drilling, but in the absence of drilling, these surveys could be conducted independently utilizing three vessels. The discharge of graywater and ballast water from these survey vessels could have localized and short-term effects on marine subsistence-harvest patterns. A geohazard/geotechnical survey was analyzed in the 2013 Shell Ancillary Activities EA (USDOI, BOEM, 2013b). There, anticipated impacts included noise, vessel presence, and small fuel spill. During 2014, BPXA conducted shallow hazard surveys in the Beaufort Sea (July-October) and conducted an on-ice survey (February-May). Potential impacts to subsistence-harvest patterns were identified to include: aircraft, on-ice vehicles, equipment, and personnel operating in the project area; however, effects to sociocultural systems were limited due to the area of the survey and its single season duration.

Exploration drilling would also occur during Years 3-5 of this period with 12 exploration wells drilled from 2 MODUs. An exploration drilling operation in the Chukchi Sea was analyzed in the 2012 Shell EP EA and further evaluated in the USDOI, BOEM (2013b). That document explains that North Slope Native communities, so closely connected to the Arctic Ocean culturally, socially and economically, are tied to the importance of subsistence whaling, hunting, and fishing, but have the possibility to benefit from economic and employment opportunities that offshore oil and gas exploration may offer.

Anticipated effects to sociocultural systems may occur from vessels, MODUs, aircraft noise, physical presence, discharges, and habitat alteration with these impact producing factors directly affecting subsistence-harvest patterns, but only marginally affecting sociocultural systems. Similar impacts are expected to result from the same activities analyzed here, but with two drilling operations rather than one. Drilling noise, aircraft noise, vessel noise, authorized discharges (muds, cuttings, graywater) and a possible small refined fuel spill are anticipated to have a negligible effect on sociocultural systems due to the limited duration of each exploration and drilling season.

The combination of effects would not likely be sufficient to displace existing social patterns. If extensive deflection from shore did actually occur for a substantial portion of the migratory bowhead population, then effects could indeed become significant as subsistence hunters might not achieve their anticipated harvest quota or potentially succumb to an increase in hazards at sea. To date, however, no long-term bowhead deflections at a population level have been demonstrated; however, seismic survey activity of the magnitude discussed in the Scenario has not been approached since the 1980's. Long-term monitoring data of bowhead migration patterns through the BOEM-funded Aerial Survey of Arctic Marine Mammals could help detect and mitigate population level deflections of bowhead whales if it were to occur unexpectedly (Clarke et al. 2012; OCS Study 2013-117; Treacy et al. 2006).

Onshore construction activities during this phase include, in Years 1-2, the completion of an exploration base, air support base, and a search and rescue (SAR) base. In Year 5, construction of the production base and supply boat terminal would commence. Construction activities would produce noise from various types of equipment, both on and offshore, and this noise has the capacity to cause disturbance to subsistence-harvest patterns. Other construction equipment noise onshore can be caused by equipment and vehicles. During this phase, shore-based construction would initiate the potential long-term presence of transient workers, which could initiate long-term social, political and economic changes in local communities (Nuttall, 2005).

Collectively, these effects would likely represent only a moderate disruption to established norms. Given the resiliency and adaptive characteristics of Inupiat social systems, the disruption is likely to be absorbed in a manner that avoids extensive or sustained displacement. However, the social patterns that emerge in the vicinity of the shorebase will likely be markedly different from the patterns that preceded development. Thus, moderate effects of social displacement will likely occur near the shorebase facility, beginning with construction during the Exploration phase.

Small spills (<1,000 bbl) could occur during exploration activities. These spills could result from refueling activities during Geological and Geophysical activities (geohazard, geotechnical or marine seismic surveys), or exploration drilling activities, and are likely to consist of refined oils. The estimated total, as well as the annual number and volume of small refined oil spills during exploration activities are displayed in Tables 4-1 and 4-2.

Due to the small size of these spills and their expected containment at the initial spill site, effects on subsistence-harvest patterns would likely be negligible and thus, effects on sociocultural systems would be negligible as well. Spills occurring in summer and not contained could be difficult to clean up and could have lingering effects in the impacted tundra and habitats of onshore subsistence-harvest patterns and the cultural practice of harvesting and sharing. Small oil spills in winter on snow or frozen tundra typically would be contained and cleaned up relatively quickly. It might be impossible to completely cleanup spills that occur on broken ice. Spills that occur are anticipated to evaporate with spills of <1bbl weathering and dispersing within 10 hours and spills of 50 bbl dispersing within 3 days.

During exploration, a tug and a refueling barge may be moored in Kotzebue Sound for oil-spill response. It is anticipated that this vessel would be moored in the Goodhope Bay area of the Sound, and would be used for near shore oil-spill response. As fuel transfer operations present an elevated risk of fuel spills and effects on sociocultural systems, transfer operations under a fuel transfer plan would have to be conducted safely, with adequate response equipment in place to provide for containment and recovery of any spilled fuel. Communities located closest to Goodhope Bay are Deering and Buckland, and the communities of Kotzebue, Noorvik, and Selawik are also adjacent to Kotzebue Sound waterways. These communities, along with others located more inland (see Section 3.3.2) rely on subsistence harvests of bowhead and beluga whales, seal, walrus, and polar bear. Thus, a small spill in Goodhope Bay could potentially impact subsistence harvest in these communities in the same manner as described above, but would not likely yield sociocultural impacts at a level of significant effect.

Mitigation

Seismic Surveys. Avoidance planning, stipulations and required mitigation, and conflict avoidance measures under MMPA authorization are defined by NMFS and USFWS would serve collectively to mitigate disturbance effects on Native ways of life and subsistence practices and likely would mitigate any consequent impacts on sociocultural systems. To ensure compliance with the MMPA, BOEM also requires seismic-survey operators to obtain from NMFS and USFWS an ITA, which could be in the form of an IHA or LOA, before commencing permitted seismic-survey activities. The ITA's mitigation and monitoring requirements would further ensure that impacts to marine mammals will be negligible, and that there will be no unmitigable adverse impact on the availability of marine mammals for subsistence use. A Plan of Cooperation with AEWC or affected villages' Whaling Captains Association would mitigate conflict between subsistence use and oil and gas operations.

Stipulation No. 2, Orientation Program, could contribute to the moderation of potential effects to cultural values that may result from project-related activities. The orientation provides information about Inupiat culture and sensitivity to community values, customs, and lifestyles. It also reviews the need for avoidance of conflicts with subsistence, and emphasizes the importance of not disturbing archaeological sites and other traditional use areas. The stipulation may thereby reduce effects from routine operations conducted by lessees.

Stipulation No. 4, Industry Site-Specific Monitoring Program for Marine Mammal Subsistence Resources, should serve to strengthen inter-organizational cooperation through coordination of activities and sharing of information with government and nongovernment organizations, especially the AEWC. By providing mitigation for subsistence harvest activity, the stipulation will reduce the attendant sociocultural effects from lessee's activities.

Stipulation No. 5, Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence-Harvesting Activities, has been proven effective in reducing conflict to subsistence harvest activities, thereby reducing the attendant sociocultural impacts. In addition, provisions in past agreements regarding assistance in the event of an accident serve to reduce risk and increase the safety of whaling crews. Through the consultation fostered by this stipulation, inter-organization communication has been strengthened.

ITL No. 1, Information on Community Participation in Operations Planning, should prove effective in reducing sociocultural effects to the extent that the lessees implement the advisory and the community participates in the planning activities. Issues explored in this participation could include perceived effects from the proximity of onshore infrastructure to the affected community.

Long-term monitoring data of bowhead migration patterns through the Aerial Survey of Arctic Marine Mammals could help detect such a deflection if it were to occur unexpectedly (Clarke et al. 2012; Treacy et al. 2006).

Additional mitigation measures identified in Section 4.3.11 would, if implemented, establish air and marine vessel traffic corridors near Wainwright to contain potential disruptions to localized subsistence activities during key moments of seasonal hunting. Such precautions would help contain adverse impacts in both subsistence harvest and sociocultural systems to a minor level of effect.

Conclusion

The greatest potential for effects during this period is related to disruption of subsistence-harvest patterns and sharing practices. Physical presence of vessels, aircraft and workers in the environment are anticipated to reduce access only minimally to areas with cultural significance or those areas important to hunting. These short-term, localized effects do not persist across seasons and are limited in time and locations. This phase should have slight measurable impacts, which are short-term and localized. The impact to sociocultural systems is anticipated to be minor. Existing lease sale stipulations, lease area deferral strategies, conflict avoidance mechanisms, long term monitoring, and other mitigating factors already enshrined in law or newly proposed are anticipated to provide sufficient protection to avoid significant sociocultural effects.

Exploration and Development (Years 6-9)

Exploration activities during this period would continue in roughly the same manner and frequency as during the preceding period. This period also features development activities, to include the completion of the shorebase and supply boat terminal in Year 6, along with construction of offshore and onshore oil pipelines during each open-water season.

Installation of an offshore oil pipeline (160 miles in Years 6-9), an onshore oil pipeline (300 miles in Years 6-9), and the remaining construction of the shorebase and supply boat terminal in Year 6 could create noise and disturbance sufficient to effect sociocultural systems. The shorebase would support offshore work and then become the connection point for the trunk pipeline from the hub platform and the pipeline across the NPR-A. Subsistence-harvest patterns would be affected by construction and dredging noise, especially near the location for the shorebase and pipeline (between Icy Cape and Point Belcher). This disruption would have indirect impacts on cultural and social values as onshore oil and gas activities can impede access to traditional hunting and herding areas, disrupting community activities and traditional practices such as sharing of resources.

During offshore pipeline installation, workers would transit through the communities of Barrow and Wainwright. Pipeline installation would also add increased vessel and aircraft presence in the Leased Area and between the Leased Area and Wainwright.

The onshore pipeline would affect subsistence during the active construction periods, and certain effects would continue for the operational life of the pipeline with potential effects to sociocultural systems. The pipeline would extend 300 miles from the Chukchi Sea, across the NPR-A to Prudhoe Bay, and connect to the Trans-Alaska Pipeline System (TAPS). Onshore pipeline construction would occur during the winter, crossing subsistence resource habitats and hunting use areas, which could affect the resources and access to the use areas. Potential effects to sociocultural systems could arise from disruptions to subsistence, cultural values and connections with the landscape, nutritional health, all of which could cause behavioral changes in communities. Some of the negative consequences could include new types of food insecurity, social stress, and poor health outcomes, which could place increasing burdens on institutional organizations. The community of Wainwright would likely experience the most effect during construction activities of the shorebase production facility and along the onshore pipeline route. Shorebase and supply boat terminal construction activities and disturbance are anticipated to remain the same as for the exploration phase.

A substantial new impact during this phase would arise from tax revenue associated with onshore infrastructure. Local economic growth associated with new revenue and distribution would also have behavioral implications. As previously analyzed, the sociocultural effects that derive from capital improvements and expanded government services are anticipated to be major in effect, but mostly beneficial for local residents.

The potential for small refined spills (<1,000 bbl) continues in the Exploration and Development period. These spills could occur during exploration as described above or during early development activities (i.e. facility construction and pipeline installations). Spills during this phase would come from similar sources having the same effects on resources as analyzed during the exploration phase. During this phase near shore oil-spill-recovery vessels could be moored in Kotzebue Sound, and effects would be the same as for the exploration phase.

Mitigation Measures

Mitigation measures would remain in place as previously described in the Exploration phase.

Conclusion

This phase of the Scenario involves the same activities as the exploration-only period, with overlap of exploration and development activities. Effects may increase due to the addition of pipeline construction and installation activities and the resulting influx of workers and equipment. Effects from these activities would cause impacts due to subsistence resource displacement and potential reduction of harvests. A loss of resources could affect cultural and social practices and could persist across seasons. During this phase some economic impacts may be realized as analyzed in Section 4.3.10. Regional sociocultural impacts following new growth of substantial economic revenue would likely achieve significant levels of effect, but a large percentage of those effects are expected to provide social benefit and would actually serve to sustain community subsistence activities. Only a relatively small percentage of revenue effects are expected to adversely diminish established standards of community well-being. Overall, the activities conducted during this time period are anticipated to have a moderate impact on sociocultural systems.

Exploration, Development, and Production (Years 10-25)

This time period includes the same aspects of exploration and development from previous sections. Exploration drilling continues during this period and impacts from that activity are included. Up to four drilling units will be in operation and there is new construction activity associated with platform installation. Meanwhile, oil and condensate production would commence, entailing the operation of offshore platforms and associated pipelines.

New direct effects include the physical presence of platforms in the OCS. During this phase, 6 gravity-based structures would be installed in Years 10, 13, 16, 19, 22, and 24. As these platforms become permanent, marine noise levels could increase from crew transports arriving at helicopter landing pads, mud pumps, gas turbines, generators, compressors, heaters, coolers, and cranes. This noise could affect subsistence-harvest patterns, which may cause changes to hunting outcomes and thus, affect sociocultural systems.

During this phase, oil production is anticipated to begin in Year 10 with subsea wells being drilled from mobile platforms in Years 12-23. These subsea wells would be linked to production platforms with pipelines placed in both the exploration and development phase. Offshore, oil pipeline construction and placement would continue in Years 13, 16, 19, 22, and 23. These pipelines would be constructed to link the Anchor Field A and Satellite Field-2 production platforms. Satellite Field A2 would be constructed in Year 24. Effects to sociocultural systems continue to be similar to those described in earlier sections of this document. Most OCS activities in the Scenario would occur in the open-water season, July through November, and these activities could disrupt subsistence-harvest patterns, since these are the primary months of harvest for most subsistence activities.

Small (<1,000 bbl) oil spills could occur during exploration, development or production. Several hundred small oil spills are assumed to occur during the 77-year Scenario. In Year 10, as oil development and production begin in earnest, large (≥1,000 bbl) oil spills could occur. It is assumed that two large oil spills could occur during the entire life of oil development and oil production activities. In this phase, spills include refined hydrocarbon product and spills of crude oil, condensate, and diesel. The potential effects of these hypothetical spills are addressed in the subsections below.

Small oil spills

Small oil spills during this phase include crude or condensate spills, diesel spills, or gas releases. Small oil spills are analyzed in Section 4.1.2.5 and Tables 4-1 and 4-2 describe assumptions about small oil spills. The small refined spill impacts would be the same as described for previous periods, having minimal effects on sociocultural systems due to their expected containment, minimal contact with habitat, and brief persistence in the environment due to their size and environmental weathering.

Crude oil can persist on water or on the shoreline longer than refined fuel spills and how long it lasts is dependent on environmental conditions at the time of the spill and the substrate of the shoreline. An estimated 220 small crude spills >1 bbl could occur during the 44-year oil production period for Alternatives I, III, and IV; an average of 5 spills per year (Table 4-2). An estimated 260 refined oil spills >1 bbl could occur during the 44-year oil production period; an average of 6 spills per year (Table 4-2). The same number of refined spills occurs over the 44-year gas sales production period. Overall, an estimated 11 crude and refined spills >1 and <1,000 bbl are assumed to occur each year for Alternatives I, III, and IV during Years 10-30. During Years 31-53, 17 spills are estimated to occur, and in Years 54 - 77, 6 spills are anticipated. Of the 2 small crude spills >500 bbl, one is assumed to occur offshore and one onshore from the 300 mi (483 km) pipeline.

Small oil spills have the potential to impact sociocultural systems by affecting subsistence-harvest patterns. The effects are the creation of a fearful perception that the resource has been contaminated. With an actual or perceived contamination that becomes pervasive, subsistence users would reduce their harvests of a particular resource. This in turn affects the cultural and spiritual practice of hunting, and the social and nutritional practice of sharing. An oil spill of any volume into a river system or lake could have effects on health and subsistence-harvest patterns and this loss would affect the majority of communities near the Leased Area. Such loss can trigger instructional organization mobilization during a spill response and impact the economic base of the community by taking local resident workers from outside of the community or region.

Large oil spills

This discussion and analysis will utilize Section 4.1.2.5 and Table 4-3 for assumptions of impacts from a large oil spill(s). The assessment of large oil-spill impacts are based on a combination of factors, including the oil spill type, spill size, spill duration, weathering, paths (trajectories) the spills follow, and the probability of one or more large spills occurring. Large oil spills are assumed to include a pipeline spill (1,700 bbl) and platform spill (5,100 bbl) of crude oil, diesel and condensate. Timing of the spill and the medium affected (ice, tundra, open water, etc.) are factors to be considered. Appendix A further describes the many facets for large oil-spill assessment.

Many of the effects described in Section 4.3.11 are applicable for this discussion.

Combined Probabilities

Large oil spills are probably the most significant potential source of effects to Sociocultural Systems attributable to Scenario activities. Effects to specific sociocultural systems fall from the impacts to subsistence-harvest patterns, and are tied to health and economics with outcomes which include environmental justice impacts. The concerns about oil spills tainting subsistence-harvest patterns and the resulting effects to cultural, spiritual, and social values are paramount. The potential effects of oil spills on whales and whaling is a concern for all marine subsistence-harvest patterns overall, since this resource typically comprises 60% of a coastal community's diet. With effects from a large oil spill causing food tainting concerns and cleanup disturbance, community infrastructure and routines can be impacted after a spill event. These indirect impacts would be experienced by communities adjoining the Chukchi Sea and could also be felt by communities away from the Leased Area and far removed from the spill.

After a spill, concerns about subsistence food consumption would be shared by all Iñupiat and Yup'ik Eskimo, including the Russian Chukchi people who reside in communities located in the Chukchi and Bering Seas along the migratory corridor used by migrating subsistence resource species. Concerns about oiled or tainted resources in these communities could curtail traditional practices for harvesting, sharing, and processing important subsistence species because all communities would share concerns over the safety of subsistence foods, the health of the communities, and the long-term effects on public and community health.

Large spills could reduce the amount of subsistence foods harvested, cause changes in traditional diets, increase risks and wear and tear on equipment if users were required to travel farther to obtain subsistence resources, and cause social stress due to the reduction or loss of preferred foods harvested in the traditional fashion (USDOI, BLM and MMS, 2003; USDOI, BLM, 2004, 2005, 2006; USDOI, MMS, 1987, 1990b, 1998, 2001, 2003, 2004, 2006a,c). These effects can cause health concerns and poor outcomes, analyzed in Section 4.3.13 and economic concerns are analyzed in Section 4.3.

Conditional Probabilities. Conditional probabilities as they relate to subsistence-harvest patterns were identified and analyzed in Section 4.3.11. This information was considered, but is not repeated here.

Effects from a Large Oil Spill on Sociocultural Systems

The effects from a large oil spill on sociocultural systems are analyzed in the 2007 FEIS (Section IV.C.1.m(4)(b)). Effects from a large oil spill on the sociocultural systems of local communities could come from disturbance from interference with subsistence-harvest patterns from oil spills and oil-spill cleanup, changes in population and employment, and stress due to fears of a potential spill and the disruptions it would cause.

Cultural and Social Values. In the event of a large oil spill, effects on traditional practices for harvesting, sharing, and processing subsistence resources could seriously curtail these practices in the short-term if there are concerns over the tainting of bowhead whales from an oil spill. Overall, effects from these sources could be expected to displace ongoing sociocultural systems by diminishing the cultural and nutritional practice of subsistence harvesting. The inability to share resources would affect communities and subsistence sharing networks. As resources become scarce, harvests become more difficult and no sharing can occur, which affects income characteristics and health. As impacts from lack of subsistence harvests are felt by communities, social well-being is affected due to displacement concerns and safety risks.

The probability of oil contacting whales is considerably less than the probability of oil contacting bowhead or beluga habitat and hunting areas, and effects from a large oil spill could result in a loss or curtailing of traditional hunting practices. If subsistence resource areas are contaminated by an oil spill, or if hunters are unable to use traditional hunting areas, the culture could be significantly impacted. This would impede sharing of harvested resources with those residing in the community and those outside of the community who rely on this sharing to maintain their cultural life. Oil-spill employment (response and cleanup) could disrupt subsistence harvest activities for at least an entire season, disrupting sociocultural systems, and displacing these systems, although cleanup activities alone are not sufficient to cause displacement.

Social and Institutional Organizations. Effects in social and institutional organizations can occur due to oil-spill employment (response and cleanup) and the sudden employment increase could have major effects, including inflation and displacement of Alaska Native residents from their normal subsistence harvest activities by employing them as spill remediation workers. 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. Immediate socio-economic impacts typically include: increased health care demands; increased crime rates; labor shortages; disruption of local government activities; and divisive social conflict between local residents and “outsiders”. Over longer duration, technological disasters systematically produce fragmented and adversarial community relations, which get exacerbated through protracted litigation. The deterioration of social relationships renders ineffective most routine stress-coping strategies so that individuals predictably experience severe levels of anxiety and depression (Picou et al. in MMS OCS Study Number 2009-006).

Far East Russia Communities. Native Chukotka people have long-term cultural practices and food security concerns and have been developing local capacity to participate in and support oil-spill response. These communities have a traditional reliance on hunting and harvesting of marine resources with a large portion of their diet supplemented with a traditional and other locally harvested resources such as domesticated reindeer. The effects from a large oil spill could exacerbate existing cultural and economic stressors on local resource populations and local hunting, causing significant impacts to Russian Native coastal communities (Newell, 2004; Nuttall, 2005).

Mitigation Measures

If development and production occurs on the level assumed in the Scenario, then it is anticipated that a chronic disruption of the existing sociocultural system would occur for a period of more than one year, with a tendency to displace existing social patterns. Existing mitigation measures play a role in reducing level of effects, but the level of sociocultural effects anticipated by the Scenario would likely exceed the significance threshold.

For example, the Scenario could lead to some degree of development-induced local employment, but these changes, particularly as they translate into Alaska Native employment, historically have been and are expected to continue to be insignificant. Even though Alaska Native employment in oil-related jobs on the North Slope is low, Alaska Native leaders continue to push for programs and processes with industry that encourage more Alaska Native hire. The NSB has attempted to facilitate Native employment in the oil industry at Prudhoe Bay and is concerned that the industry has not done enough to accommodate training of unskilled laborers or to accommodate their cultural needs in participating in subsistence hunting. The NSB also is concerned that industry recruits workers using methods more common to Western industry practices and would like to see the oil industry make a more concerted effort, and one that is more appropriate to the Inupiat, to hire NSB residents. In particular, hiring and employment practices which value and facilitate continued participation in the subsistence seasonal round are encouraged by the NSB and local residents. Few village residents currently are employed by the oil industry, even though recruitment efforts are made and training programs are available.

More importantly, during the Production phase of the Scenario a new concern for mitigation arises with the flow of oil through constructed pipelines, both offshore and onshore. The primary environmental issue of oil development for local residents has always been the plausible risk of oil spill. No matter how well or how thorough research and modeling data may help to clarify the parameters and consequences of a possible spill event, research and modeling can never resolve the underlying political issue of what constitutes an acceptable level of community risk in relation to perceived benefits. Neither can they ever resolve the fundamental issue of asymmetric risks and benefits distributed among various stakeholder groups. The fact remains that an OCS production scenario in the Chukchi Sea ─ no matter its potential benefits for local, state, and national interests ─ would place the greatest risk of technological disaster directly on the shoulders of local residents. For this reason, in order to achieve social equity and minimize negative sociocultural impacts to affected communities, it is necessary to redistribute risks and rewards to the extent reasonable. One obvious method to mitigate the unequal risk/reward structure is to ensure delivery of OCS produced natural gas to NSB communities through a network of spur lines, in the cases where it is economically practical. Eventual construction of a gas treatment plant and/or distribution center on the North Slope that could feed some of the energy needs of nearby communities would provide substantial additional mitigation to projected long term sociocultural impacts. BOEM cannot require implementation of this type of mitigation, but such accommodation would help to offset somewhat the valid ongoing concerns about adverse impacts from a large OCS oil spill, although it would also contribute to environmental impacts through construction and maintenance of the gas treatment plant and spur lines.

Conclusion

This period involves the same activities as the previous periods, but adds effects from platform installation, cleanup crew presence and operations, as well as pipeline maintenance and large oil spills. Effects from large oil spills or disturbance/displacement of community members and their resources along the 300 mi (483 km) onshore pipeline route would persist across seasons. A substantial spill would certainly impact sociocultural systems in a major way. Locally, the influx of cleanup crews can bring burdens on these systems related to potential increases in disease and crime, use of community resources or businesses by workers. However, large spills can also affect sociocultural systems by reducing subsistence harvest resource populations and contaminating subsistence resource habitats, creating a perception of tainting and tainting concerns, and rendering resources as unfit to eat. This impacts health and household economics primarily due to increased costs and distance traveled to hunt, usually during unsafe conditions. Should any resource population decline significantly, the cascading potential sociocultural impact to communities who rely on subsistence would be severe.

Overall, the activities conducted during this time period are anticipated to have a moderate to major impact on sociocultural systems. Sociocultural impacts could be major if a large oil spill made subsistence resources undesirable, unsafe or significantly reduced in numbers. Sociocultural impacts from potential economic revenue would also be major, but primarily beneficial in nature.

Development and Production (Years 26-50)

Development and production activities during this period would continue in roughly the same manner and frequency as during the preceding periods analyzed above. This period includes seismic surveys, development of a satellite field and continuation of oil production. Construction activities would include construction of two additional production platforms and several offshore pipelines in Years 27-30. Offshore and onshore gas pipelines would be installed, causing impacts similar to those described for the oil pipelines.

Noise and disturbance impacts to sociocultural systems would be similar to those described above. There would be temporary, localized affects to subsistence resource habitats from construction and placement of gas pipelines. These could affect harvests which in turn affect cultural values and sharing networks. These effects would not persist across seasons. During this period, it is anticipated that sociocultural systems could adapt to the ongoing activities in the Chukchi Sea. It may be anticipated that this adaptation to activities, patterns of worker influx, and habitats could become normalized. Over time, these adaptations have been shown with onshore oil and gas development.

Construction of an onshore gas pipeline would result in affects to sociocultural systems, and the installation of a gas pipeline adjacent to the oil pipeline could minimize effects to resources. Long-term access and maintenance could affect communities by having permanent operation and maintenance workers traveling to the villages. This may displace some community members if these workers are not housed in separate company enclaves.

Small refined and crude spills (<1,000 bbl) and large (≥1,000 bbl) crude, condensate or diesel spills could occur during development and production. Two large spills are assumed to occur during the entire life of development and production. These spills are analyzed in previous phases and effects would be the same if spills occurred during this period. The development and production of OCS gas in Year 31 raises the potential for dry gas releases. Gas releases could occur during development and production. Up to three gas releases were considered: one from a platform and two from an onshore pipeline.

Gas releases with or without explosion hazards could occur. This analysis estimates one 10 million cubic foot release occurs offshore from the facility and two 20 million cubic feet releases occur onshore from the 300 mi (483 km) gas pipeline. 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 would be short term (up to one day). Effects to sociocultural systems would be negligible considering the low volume, short duration, rapid dissipation, and localized nature of a release. However, if local workers were involved in a gas release with resulting explosion and fire, potential casualties as well as stress levels on family members would increase through the event and this would impact sociocultural systems. Onshore, if community members were located near a release, impacts could be located in the vicinity of the release by inhaling gases; however, this is highly unlikely. Many NSB and NWAB communities have emergency response plans for events such as these to protect their communities. The distance between any of the Leased Areas and the coast is such that it is extremely unlikely that OCS gas releases would contact the coast. Natural gas will weather and dissipate quickly in the atmosphere, preventing widespread effects. Overall, the effects from a natural gas blowout should be much lower than that which would be expected for a similar crude oil accident.

Mitigation Measures

If development and production occurs, then it is anticipated that a chronic disruption of the existing sociocultural system would occur for a period of more than one year, with a tendency to displace existing social patterns. Existing mitigation measures play a role in reducing the level of effects, but sociocultural effects anticipated by the Scenario would likely exceed the significance threshold.

Conclusion

This period involves many of the same development and production activities as the previous period. Overall, the routine activities conducted during this time period are anticipated to have a moderate to major impact on sociocultural systems. Sociocultural impacts could be major if a large oil spill made subsistence resources undesirable, unsafe or significantly reduced in numbers. Sociocultural impacts from potential economic revenue would also be major, but primarily beneficial in nature.

Production and Decommissioning (Years 51-77)

Production activities would have become routine as oil production shifts to gas production. No additional construction or seismic survey activities are anticipated. Beginning in Year 60, the removal of each platform may benefit subsistence hunting. There is, however, an extended period (Years 54-65) of additional drill rig activity which may extend effects to subsistence-harvest patterns, thereby affecting cultural and social values. During the production and decommissioning phase, both oil and gas resources are depleted, facilities begin to shutdown, wells are plugged, and processing modules are moved off platforms, creating a potential influx of workers to the North Slope for decommissioning activities.

Decommissioning activities that require field crews include: plugging and abandoning wells, decommissioning subsea pipelines, and removal of production equipment and platforms. As in earlier periods which experienced an influx in workers, this new period creates a potential source of disturbance to sociocultural systems due to diminished sense of community well-being and increased stressors placed on public infrastructure, such as transportation facilities. Small (<1,000 bbl) and large (≥1,000 bbl) crude, condensate or diesel spills could occur until Year 53, when crude oil and natural gas liquid condensate production ends. Large diesel spills and gas releases could occur through Year 74. Refined small spills could occur through Year 77. Effects from these spills on sociocultural systems would create the same impacts described in earlier sections.

Mitigation Measures

Mitigation measures would remain in place as previously described in the other sections.

Conclusion

This time period involves the same activities as the previous period, but there would be no additional construction. Platforms would gradually be removed. Long-terms effects from platform and pipeline operation/maintenance would continue, but at a reduced level. Effects from disturbance/displacement along the 300 mi (483 km) oil/gas pipeline route would persist, but at a reduced level. Overall, the activities conducted during this time period are anticipated to have a moderate impact due to the decreasing level of activities.

Conclusion

Over the life of the Scenario, several impact producing factors could affect sociocultural systems. Many of these (vessel/drilling/aircraft noise, physical presence, habitat alteration, and discharges) would have minor to moderate levels of effects because of their capacity to cause direct impacts to subsistence-harvest patterns (deflection, alteration of migration patterns), with implications for disrupting broader sociocultural systems. Periods of construction activity would likely have a localized, short-term effect to communities due to potential harvest disruptions and the influx of transient workers. However, the construction of shorebase facilities and pipeline corridors could result in more extensive alterations to existing sociocultural patterns. Sociocultural impacts from potential economic revenue would also be major, but primarily beneficial in nature. The greatest degree of impacts could occur from large oil spills, which could cause long-term tainting of subsistence resources, making them unavailable or undesirable for use. Additional socio-economic impacts from a spill typically include: increased health care demands; increased crime rates; labor shortages; disruption of local government activities; and divisive social conflict between local residents and "outsiders". Over longer duration, technological disasters systematically produce fragmented and adversarial community relations for some people, which get exacerbated through protracted litigation. The deterioration of social relationships renders ineffective most routine stress-coping strategies so that some individuals may experience severe levels of anxiety and depression. If this occurs, the impacts to sociocultural systems could become severe.

Anticipated impacts to sociocultural systems from the Scenario range from minor during Exploration (Years 1-5), to moderate during Exploration and Development (Years 6-9), moderate to major during Exploration, Development, and Production (Years 10-25), moderate to major during Development and Production (Years 26-50) and moderate during Production and Decommissioning (Years 51-77). Where exploration activities overlap with development and production activities, the highest likelihood of adverse impact occurs from years 10-50. Once exploration drilling ceases, impacts are reduced, with lower levels of effect.

4.3.12.2. Alternative II – No Action

Under Alternative II, Lease Sale 193 would not be affirmed and no current leases would be available for further exploratory drilling or other oil and gas development. Impacts from the Scenario on sociocultural systems from possible disruption due to noise, physical presence, and real or perceived contamination associated with the development of OCS oil and gas resources and the construction of land-based facilities needed to support exploration and subsequent production would not occur. Conversely, no economic benefit to Alaska North Slope communities from these activities would accrue. Consequently, selection of Alternative II would result in negligible impact to sociocultural systems.

4.3.12.3. Alternative III – Corridor I Deferral

Alternative III provides the largest deferral area of the action alternatives – a corridor approximately 60 miles (97 km) wide along the Chukchi Sea shoreline. If Alternative III were selected, the distance from the shore to many activities would be greater than under Alternatives I and IV. No exploration or development drilling or platform construction would occur within the corridor, although certain activities (i.e., installation of a pipeline extending from the leases outside the corridor to the shore) could occur there. Of the Lease Sale 193 leases, only five are within Corridor I.

The minimum distance from shore under Alternative III would be greater for the following activities than for the other action alternatives: length of pipeline from a platform to shore; travel distances from vessels and aircraft; discharges, emissions and noise associated with drilling and platform installation and operation. 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.

The larger deferral corridor could provide a small additional measure of protection to subsistence harvest resources by increasing the minimum distance of leases from the Chukchi Sea shoreline. A proportional reduction in impacts would be expected on the following components of sociocultural systems:

- **Subsistence values:** Loss or damage to property or equipment used in wildlife harvesting and threat of present or future loss of income and/or income-in-kind from wildlife harvesting would be reduced.
- **Social well-being:** Concerns over risk, safety and health and displacement/relocation of subsistence activities would be reduced.

Overall effects of this alternative, including those from oil spills, would be approximately the same as for the Proposed Action. The reduction of effects for subsistence harvest activities could be marginally reduced, but would not substantially alter the overall effects to sociocultural systems. Using the Impacts Scale in Section 4.2, the level of impacts under Alternative III would be consistent with the other action alternatives.

4.3.13. Public Health

The analysis that follows evaluates the impacts to Public Health from the Scenario over time. The structure of this analysis differs from that of other resources in this chapter because Public Health impacts are tied not only to impacts on subsistence-harvest patterns (and therefore by extension to impacts on marine and terrestrial mammal species) and sociocultural systems, but also to economic impacts. Impacts to air and water quality may also impact Public Health. What follows is a summary of impacts from each of the aforementioned sections, accompanied by a short explanation of how these impacts interact with public health. It should be noted that some exploration, development, production, and decommissioning activities would occur concurrently during the 77-year life of the Scenario; these activities would have overlapping effects on Public Health. For example, during Years 10-25 of the Scenario, each phase of activities - exploration, development, and production – would occur, causing overlapping impacts on subsistence harvest resources, sociocultural systems, the economy, and air and water quality.

4.3.13.1. Alternatives I and IV

There is a certain amount of general health dysfunction in any community, separate from oil and gas development. Although health issues such as diabetes and cancer do exist in NSB communities, it is difficult for the purposes of analysis to establish a connection to oil and gas activities. Therefore, although these public health issues do exist on the North Slope, this analysis will only speak to those aspects of public health with a documented connection to oil and gas activity.

Potential exploration and development can cause specific stresses on the Alaska Native population residing in communities that could be affected by industrial activity in the Chukchi Sea and associated infrastructure on land (MMS, 2007).

Oil and 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 OCS and onshore 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 region wide 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 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 oil and 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

4.3.13.1.1. Summary of potential impacts to Public Health via other resources

Marine and Terrestrial Mammals

See Section 4.3.7 Marine Mammals and Section 4.3.8 Terrestrial Mammals for a detailed analysis of impacts of the Scenario to marine and terrestrial mammals. Marine or terrestrial mammals could be impacted by noise, physical presence, discharges, or oil spills, any of which has the potential to deflect animals from migration routes and habitats or disturb normal biological patterns. Large spills also have the potential to impact animal populations not only through direct mortality and potential reduction of certain resources, but also by contamination. The overall impacts of the Scenario to marine and terrestrial mammals varies by species, and although in general impacts are negligible to minor, some IPFs, such as aircraft traffic and oil spills, could result in moderate impacts to certain species. Impacts to marine and terrestrial mammals could impact subsistence-harvest patterns, which could in turn impact Public Health. If subsistence-harvest patterns are affected, Public Health could be impacted due to a possible reduction in availability of subsistence resources, which could mean a reduction in diet quality if store-bought/processed foods are substituted for traditional subsistence foods.

Economy

Increased oil and gas activity could substantially contribute to the local economy. This could impact Public Health both on an individual level—greater personal income—and the community level, with improved local infrastructure, school systems, law enforcement, and health services. More disposable income could provide residents the means to better gear and hunting equipment, though time spent working may increase. Improved community infrastructure would provide resident with better and more accessible health, education, and law enforcement services, though there may also be an attendant increase in population. Overall, the Scenario would have substantial overall positive economic impacts for many decades, and thus on public health. For further detail about the impacts of the Scenario to the economy, see Section 4.3.10.

Subsistence-Harvest Patterns and Sociocultural Systems

If subsistence-harvest patterns and sociocultural systems are impacted this means local diets and community organization will be impacted, which means impacts to public health will result. Harvest loss, if sustained, could result in disruption to food sharing patterns or cultural resources, creating cultural stress and diminished nutritional status for some portion of the community. This in turn can erode or damage community cultural values and create stress on local institutions such as health care delivery systems. As analyzed in Section 4.3.11 Subsistence-Harvest Patterns, if detectable impacts to subsistence-harvest patterns were to occur, the highest potential for change would be in the community of Wainwright, with likely impacts also reaching to Point Lay, Point Hope, and Barrow. As analyzed in Section 4.3.10 Economy, if substantial economic effects were to materialize over the course of the Scenario, then the potential for chronic displacement of sociocultural patterns may expand to all communities of the North Slope Borough. See Section 4.3.12 Sociocultural Systems for a complete description of impacts of the Scenario to Sociocultural Systems.

Air quality

A reduction in air quality as a result of the activities associated with the Scenario has the potential to impact public health by potentially introducing into the environment emissions that are detrimental to human health. These impacts are unlikely, however, since each stage of operation within each phase of the Scenario results in a negligible air quality impact because of the countervailing effects of actual operations together with dilution and diffusion of the pollutants over time and distance. The overall analysis of air quality demonstrates a negligible impact on the Alaska North Slope, except in the case of a large oil spill, in which case the impact could be moderate because of VOC emissions that would be long lasting and widespread, but less than severe. See Section 4.3.2 Air Quality for a detailed examination of impacts of the Scenario to Air Quality.

Water quality

A reduction in water quality as a result of the activities associated with the Scenario has the potential to impact public health if discharges or oil spills occur in waters used for subsistence activities. Considering all effects on water resources from all activities associated with the Scenario, the impacts to water quality could be moderate due to the potential for two large oil spills (5,100 bbl and 1,700 bbl), various permitted discharges, and the potential effects of introduced aquatic invasive species. For further detail on impacts of the Scenario to water quality see Section 4.3.1.

Worker influx

Aside from impacts to Public Health connected to impacts to other resources, public health of NSB communities could also be impacted by the influx of workers associated with oil and gas development.

As stated in Section 4.3.12, following the experience of development at Prudhoe Bay and adjacent satellite fields, social research has documented that NSB residents do indeed perceive negative changes in traditional living. Although specific studies of the impacts from oil and gas development to Public Health of NSB communities have not been done, it is possible that impacts could be similar to the well-documented impacts occurring during oil and gas booms in other small, remote, and/or Native communities in the lower 48 and Canada. A Washington Post article, “The Dark Side of the Boom”, describes impacts of the Bakken boom in North Dakota: “The arrival of highly paid oil workers living in sprawling ‘man camps’ with limited spending opportunities has led to a crime wave -- including murders, aggravated assaults, rapes, human trafficking and robberies -- fueled by a huge market for illegal drugs, primarily heroin and methamphetamine.” The article quotes a local judge as saying “crime has tripled in the past two years and that 90 percent is drug-related.” (http://www.washingtonpost.com/sf/national/2014/09/28/dark-side-of-the-boom/)

Articles pertaining to booms in other regions detail similar problems, and explore the common factors that come together to create these types of public health risks. Anywhere a transient but highly-paid workforce undertakes difficult, dangerous jobs with little to do during off hours, substance abuse and the associated crimes can result. According to an article in Benefits Canada, ”the pressures of an oil worker’s job—including remote workstations, extended time away from families and the work itself—exacerbate issues that affect workers in more traditional settings, like relationships, family and financial problems.” Furthermore, “industry expansion and a high global demand for oil have brought more and more workers into the sector’s unique work environment.” (http://www.benefitscanada.com/benefits/health-wellness/problems-in-the-patch-15035).

4.3.13.1.2. Impacts of the Scenario through Time

Many aspects of Public Health will be impacted if marine and terrestrial mammals, subsistence-harvest patterns, sociocultural resources, the economy, and air and water quality are impacted. Each of these resources has its own "Story Through Time" section in this document, where impacts of overlapping phases of development are examined. For the sake of this analysis, it is assumed that where impacts to any of these resources increase, so do impacts to Public Health, as described above. This assumption is applied throughout this section and willl not be repeated below.

Exploration (Years 1-5)

The primary activities that could impact Public Health during this period are marine seismic surveys and the beginning of exploratory drilling. Impacts to marine and terrestrial mammals from these activities would be negligible due to the localized area of effects for most IPFs. These short-term, localized effects do not persist across seasons and are limited in time and locations. This phase should have slight measurable impacts to subsistence and sociocultural systems which are short-term and localized; the impact to sociocultural systems is anticipated to be minor. Impacts to water quality from activities in Years 1-5 would be detectable short-term, localized and less than severe, and thus would be considered minor. Impacts to air quality from drilling emissions or evaporative VOC emissions from oil spills during the first five years of exploration is negligible. Effects to the economy will begin to be realized during this phase, as workers would be needed for jobs for the construction and operation of infrastructure. While some of these jobs would be obtained by local North Slope residents (i.e., local residents working as Protected Species Observers), the vast majority of these jobs would be obtained by non-locals with the technical skills required to conduct the activities. If workers are housed in enclave-type developments, impacts to Public Health would be negligible. If they are not, impacts could be moderate.

Impacts to resources affecting Public Health during this period would be negligible to minor, with the exception being impacts to the Economy, which could be moderate. Taken together with the beginning of the influx of workers into the area, and assuming the mitigation measures pertaining to enclave development (described above) are implemented, the overall impact of this phase to Public Health would be moderate due to the fact that regardless of housing, additional workers in these areas would still likely put additional strain on already limited medical services. If workers are not housed in enclaves but are instead absorbed by the communities, the resulting potential increase in alcohol and drug-related crimes could bring impacts to Public Health of this phase to major.

Exploration and Development (Years 6-9)

Exploration seismic and drilling will continue and development would commence, including construction of offshore oil pipelines. The additive and synergistic effects of activities on marine mammals during the Exploration and Development phase would be similar to those described for Years 1-5, though pipeline installation would add new sound and vessel presence issues to the environment. Dredging noise could also affect marine mammals, though effects would vary with marine mammal species and species location. Additional aircraft traffic has the potential to impact terrestrial mammals, but these impacts are anticipated to be transitory and therefore negligible. The onshore pipeline would affect subsistence during the active construction periods, and certain effects would continue for the operational life of the pipeline with potential effects to sociocultural systems. Air and water quality impacts will be similar to those for the first five years of development with increased frequency and intensity, though impacts will remain negligible to minor. A large oil spill (5,100 bbl offshore or 1,700 bbl onshore) has the potential to occur in this period, and throughout the life of the Scenario. Impacts to all resources from a large spill could be moderate to major; large spills are possible throughout the life of the project. Economic impacts will also be increasing during this period, with property tax revenues increasing as the worker influx continues.

Overall, impacts to Public Health during this period will remain minor, with the exception of a large oil spill, which could result in moderate or even major impacts. As with all phases of development, impacts to Public Health from an influx of workers would be mitigated by enclave housing. Without these measures, impacts could increase up to major as activity associated with the Scenario increases.

Exploration, Development, and Production (Years 10-25)

During this period, Exploration, Development, and Production activities would proceed concurrently. Impacts to marine and terrestrial mammals from seismic, drilling, and associated infrastructure construction will increase and there will be up to four drilling units operating, though overall impacts will vary by species (see Sections 4.3.7 and 4.3.8). Similarly, effects of a large spill on marine or terrestrial mammals, though variable by species, would generally be moderate to major. Most offshore activities in the Scenario would occur in the open-water season, July through November, and these activities could disrupt subsistence-harvest patterns, since these are the primary months of harvest for most subsistence activities. Effects from a large oil spill on the sociocultural systems of local communities could come from interference with subsistence-harvest patterns from oil spills and oil-spill cleanup, changes in population and employment, and stress due to fears of a potential spill and the disruptions it would cause. Impacts to water quality from these concurrent activities could be moderate; major if a large spill occurred. The potential increase in emissions from this phase of the Scenario would be local and temporary and would not result in long-term impacts; therefore, impacts to air quality are expected to be negligible, though emissions from a large spill could result in a moderate impact. Economic impacts will continue as described above, with continued or increased employment and income increasing impacts to a major level.

Overall, environmental pressures on the resources that influence Public Health will increase during this period, while positive impacts to the economy continue. Impacts to Public Health during this period would be moderate to major, depending on whether a large oil spill occurs.

Development and Production (Years 26-50)

Development and production activities during this period would continue in generally the same manner and frequency as during the preceding period, as analyzed above. Impacts to marine and terrestrial mammals would vary by species, (see Sections 4.3.7 and 4.3.8) and are expected to be minor to moderate, depending on the whether an oil spill occurs. There would be temporary, localized effects to subsistence resource habitats from construction and placement of gas pipelines. These could impact harvests, which in turn affects cultural values and sharing networks. These effects would not persist across seasons. Impacts to water quality from all activities, including oil spills, would be detectable, long-lasting and extensive, but less than severe. Overall impacts to water quality would be moderate, but localized, and therefor unlikely to have other than negligible impacts Public Health on a systemic scale. Overall effect of the emissions projected to occur throughout this time period could cause moderate impacts because they would be long lasting and widespread, but less than severe. Taken with the influence of pollutant dilution and diffusion, in combination with effects of time and space, overall impacts to air quality would be negligible. Economic impacts will continue as described above, with continued or increased employment and income maintaining impacts at a major level. The influx of workers would continue, with possible impacts to the local communities in terms of both cultural tension and due to additional strain on public health services, including law enforcement. These impacts could be mitigated to a negligible impact with enclave development as described above.

While environmental pressures on marine and terrestrial mammals, and thus on subsistence and sociocultural systems, continues during this period, most impacts are temporary and localized. Economic and social impacts from more money and more people flowing into the area would be long-term and have both positive and negative impacts. The overall impact to Public Health could elevate to major during this period, although with largely positive major impacts. The exception is, as with previous phases, in the event of an oil spill, which could result in major negative impacts to Public Health.

Production and Decommissioning (Years 51-77)

During this phase, aircraft and vessel traffic will still potentially impact marine and terrestrial mammals, but construction will have ceased. Overall impacts to marine and terrestrial mammals for this phase would be moderate to minor, though impacts vary by species (see Section 4.3.7 and 4.3.8). Production activities would have become routine as oil production shifts to gas production. No additional construction or seismic survey activities are anticipated. Beginning in Year 60, the removal of each platform may benefit subsistence hunting. There is, however, an extended period (Years 54-65) of additional drill rig activity, which may extend effects to subsistence-harvest patterns, thereby affecting cultural and social values. During the production and decommissioning phase, oil and gas resources are depleted, facilities begin to shutdown, wells are plugged, and processing modules are moved off platforms, creating another potential influx of workers to the North Slope for decommissioning activities. Impacts of this remain as described above. Impacts to water and air quality would also be moderate, as described above. Each stage of operation within each phase of the Scenario results in a negligible air quality impact when considering the countervailing effects of actual operations together with dilution and diffusion of the pollutants over time and distance.

Conclusion

Positive impacts to the economy over time would have corresponding positive impacts on Public Health due to additional funding available to improve community support infrastructure. Potential negative impacts could result from the increase in population as the workforce swells, which could result in more strain on this infrastructure if this influx is not mitigated through well-managed enclave development, to include a self-sufficient medical clinic. Other mitigation measure that could reduce impacts to Public Health include working with local governments to recognize and address any appropriate mitigation measures available to reduce potential health effects of any proposed action from the OCS.

Potential environmental impacts to marine and terrestrial mammals, air and water quality could negatively impact subsistence-harvest patterns and sociocultural systems, resulting in a moderate impact to Public Health. Overall, impacts to Public Health from the Scenario have the potential to be major, both positively and negatively.

4.3.13.2. Alternative II

Under Alternative II, Lease Sale 193 would not be affirmed and no current leases would be available for further exploratory drilling or other oil and gas development. Impacts from the Scenario on public health from possible disruption due to noise, physical presence, and real or perceived contamination associated with the development of OCS oil and gas resources and the construction of land-based facilities needed to support exploration and subsequent production would not occur. Conversely, no economic benefit to Alaska North Slope communities from these activities would accrue. Consequently, selection of Alternative II would result in negligible impact to public health.

4.3.13.3. Alternative III

Alternative III provides the largest deferral area of the action alternatives – a corridor approximately 60 miles (97 km) wide along the Chukchi Sea shoreline. If Alternative III were selected, the distance from the shore to many activities would be greater than under Alternatives I and IV. No exploration or development drilling or platform construction would occur within the corridor, although certain activities (i.e., installation of a pipeline extending from the leases outside the corridor to the shore) could occur there. Of the Lease Sale 193 leases, only five are within Corridor I.

The minimum distance from shore under Alternative III would be greater for the following activities than for the other action alternatives: length of pipeline from a platform to shore; travel distances from vessels and aircraft; discharges, emissions and noise associated with drilling and platform installation and operation; and the source of a VLOS. Some disruption to public health could occur, especially if development occurs near a coastal community, where disruptions would have a tendency to displace existing social patterns.

The larger deferral corridor could provide a small additional measure of protection to subsistence harvest resources by increasing the minimum distance of leases from the Chukchi Sea shoreline. A proportional reduction in impacts to public health would be expected to subsistence through loss or damage to property or equipment used in wildlife harvesting, and to social well-being due to concerns over risk, safety and health and displacement/relocation of subsistence activities.

Overall effects of this alternative, including those from oil spills, would be approximately the same as for the Proposed Action. The reduction of effects for subsistence harvest activities could be marginally reduced, but would not substantially alter the overall effects to public health, which would be major.

4.3.14. Environmental Justice

The intent of the "environmental justice" (EJ) initiative as articulated by Executive Order 12898 is to promote fair treatment of people of all races and income levels, so no person or group of people bears a disproportionate share of the negative effects from a country's domestic and foreign programs. As noted in Chapter 3, all of the Chukchi Sea coastal communities in the NSB and NWAB – the region potentially most affected by the oil and gas activities comprising the Scenario – warrant consideration in an EJ analysis analysis as they are classified as EJ communities on the basis of their proportional American Indian and Alaska Native membership.

Analysis of the impacts of OCS oil and gas development projects on environmental justice issues follows guidelines described in the Council on Environmental Quality's (CEQ's) Environmental Justice Guidance under the National Environmental Policy Act (CEQ, 1997b). The analysis method has three parts:

1. A description of the geographic distribution of low-income and minority populations in the affected area is undertaken
2. An assessment is conducted to determine whether oil and gas activities would produce impacts that are high and adverse; and
3. If impacts are high and adverse, a determination is made as to whether these impacts would disproportionately affect minority and low-income populations

Iñupiat subsistence-harvest practices and patterns are fundamental to NSB and NWAB communities, not only providing important food resources, but also forming the basis for core community values and cultural identity. Effects to subsistence harvests lead inevitably to changes in sociocultural systems and community health, resulting in EJ impacts. More specifically, the activities comprising the Scenario have the potential to impact EJ through:

- Impacts to subsistence-harvest patterns/species causing a reduction in traditional food and causing food insecurity issues
- Oil spills resulting in subsistence resource tainting, or the perception of contamination
- Construction and operation of OCS oil and gas development projects could affect EJ if any adverse health and environmental impacts resulting from exploration, development, production, or decommissioning are high and if said impacts disproportionately affect minority and low-income populations.

If analysis determines health and environmental impacts are not significant, there can be no disproportionate impacts on minority and low-income populations. In the event impacts are significant, disproportionality would be determined by comparing the proximity of any high and adverse impacts with the location of low-income and minority populations

Any disproportionately high adverse impacts to a NSB or NWAB community are considered "significant" EJ impacts.

4.3.14.1. Alternatives I and IV

4.3.14.1.1. Impact Producing Factors

IPFs associated with the Scenario which have the potential to affect EJ are the same IPFs identified and analyzed in Sections 4.3.10, 4.3.11, 4.3.12, and 4.3.13. Each of these IPFs is organized by phase of oil and gas activity (i.e., exploration, development, production, and decommissioning). IPFs which occur during multiple phases are addressed in the phase in which they first appear and are then referenced where applicable. The primary categories of IPFs affecting subsistence are noise, physical presence, discharges, habitat alternation, and accidental oil spills. Accidental spills, though not considered routine oil and gas activities, have the potential to occur during each phase of the Scenario. General impacts of small and large spills are addressed as IPFs in the subsection where they have the potential to occur. The impacts of spills within the larger context of all other activities that occur during each period are analyzed below in the "Impacts of the Scenario through Time."

Exploration

The activities associated with the exploration phase that have potential to impact EJ include vessel-based marine surveys, vessel and aircraft support, exploration and delineation well drilling, drilling unit placement, shorebase construction, and onshore road construction.

Noise

Noise can impact can impact EJ in the same manners described in Section 4.3.13. Noise can come from seismic surveys, vessels, aircraft, drilling, construction, and various other activities.

Physical Presence

Physical presence can come from man-made structures or a consequence of human interaction in a remote location such as the NSB. Impacts from physical presence are analyzed in Section 4.3.13.

Physical presence can come from vessels, aircraft, and field crews/oil workers.

Discharges

There are several types of discharges that can occur during exploration. Discharges released during exploration can be due to:

- Release of muds and cuttings at well drilling sites
- Vessel and MODU releases of graywater from galleys, bathroom, and other on board crew use areas
- Although illegal, sludge, garbage, or other debris from vessels which pose risks to subsistence-harvest patterns

Habitat Alteration

Habitat alterations occur when the specific environment of a resource is altered or affects subsistence-harvest patterns, sociocultural systems, or public and community health. Habitat alterations are analyzed in Section 4.1.2.4 and can have effects on EJ.

Accidental Oil Spills

Small Refined Spills (<1,000 bbl), analyzed in Section 4.1.2.5, although accidental, generally are routine, expected, and have the potential to occur during exploration activities. Small spills may be contained on a vessel or platform or those spills reaching the water, may be contained by booms or absorbent pads.

During exploration, a possible refueling barge may be anchored in Kotzebue Sound. This barge will be located here due to the conditions for mooring in the sound and small spills of 50 bbl or less could occur from this barge. Since there is a potential for a fuel spill during fuel transfers between vessels and a fuel spill would potentially introduce hydrocarbons to the water; this spill would be short-lived due to volatilization of light hydrocarbons and still potentially affect fish and marine mammals used for subsistence.

Development

Development is the construction of facilities to produce hydrocarbons and move them to market. The same IPFs that could arise from development activities are analyzed in the exploration phase.

Production

Production is the production of hydrocarbons and gas throughout the life of the field. The same effects from those IPFs that could arise from production activities are analyzed in the exploration and development section.

Accidental Oil Spills

The production phase entails IPFs associated with large oil spills as well as gas releases. The effects of accidental oil spills and gas releases were are analyzed in Sections 4.3.11, 4.3.12, and 4.3.13.

Impacts of the Scenario through Time

This section provides analysis of impacts to EJ as it occurs through the 77 years of the Scenario. This analysis references particular oil and gas activities analyzed previously that could occur during each relevant time period and analyzes their impacts against the backdrop of a dynamic affected environment. Whereas previous sections have focused on identifying relevant IPFs and the types of environmental impacts they may cause, this section more specifically accounts for the level at which each IPF occurs during a given phase, the overlap of IPFs, and any additive or synergistic impacts which may result. In total, these sections tell the story of how the activities comprising the Scenario could implicate Environmental Justice concerns through time.

The indigenous Arctic coastal population maintains a largely symbiotic relationship with the marine environment with some still leading subsistence way of life with many heavily relying on the marine environment for food, warmth and cultural identity. Offshore and onshore oil and gas activities that damage the marine environment would fundamentally interfere with indigenous peoples' lives and thus, become an EJ impact.

Exploration (Years 1-5)

OCS activities during this period include seismic surveys (deep penetration and shallow hazard) and exploration and delineation drilling operations. Onshore activities during this period include construction activities that include an exploration base, air support base, and a search and rescue (SAR) base. Potential impacts associated with these activities were analyzed in-depth in Sections 4.3.11, 4.3.12, and 4.3.13, which address Subsistence-Harvest Patterns, Sociocultural Systems, and Public Health, respectively.

Conclusion. The resulting impact to EJ is anticipated to be minor to major during this period, and is linked directly to subsistence practices, described in the section above. Major effects could result from anthropogenic noise unless mitigation measures are followed.

Exploration and Development (Years 6-9)

Exploration activities during this period will continue in roughly the same manner and frequency as during the preceding period, analyzed above. This period includes development activities including the completion of the shorebase and supply boat terminal in Year 6 along with both offshore and onshore pipeline construction occurring during each open-water season.

Construction of an offshore oil pipeline (160 miles in Years 6-9), an onshore oil pipeline (300 miles in Years 6-9), and the complete construction of the production base and supply boat terminal in Year 6 could create noise and disturbance to subsistence harvest resources. The shorebase will support offshore work and then become the connection point for the trunk pipeline from the hub platform and the pipeline across the NPR-A. The Scenario identified the shorebase and pipeline would be located between Icy Cape and Barrow.

During both the open-water season and during winter construction, hunts for seal, walrus, polar bear, caribou, fish, and birds could be disrupted primarily for subsistence harvests of Wainwright and Point Lay. The most harvested resource to be disrupted for these communities is bearded seal, taken by Wainwright hunters during June through August and by Point Hope hunters during April through August. Bowhead whales are key subsistence resources for these communities and any effects from construction may impact these resources offshore if spring whaling were to occur into the month of June. Hunting and harvest of bowhead whales has not historically occurred in June. The beluga whale harvest for Wainwright and Point Lay could be affected during open-water pipeline construction. This culturally significant resource is harvested by Wainwright in July and by Point Lay in June and July. The hunting and harvesting of beluga whales for each community occurs in the area where an onshore pipeline could meet the first onshore pump station.

During offshore pipeline construction and installation, sediment displacement and soil deposition from trenching and burial will cause changes in food resources for subsistence use species. For example, walrus, hunted by the communities of Barrow, Wainwright, and Point Lay are foragers and feed on benthic bivalve mollusks and other lower trophic marine organisms. Pipeline installation will also add increased vessel presence in the Leased Area and between the Leased Area and Wainwright or Barrow.

Offshore pipeline effects to subsistence-harvest patterns would be confined to the period of construction. Other disturbance impacts on subsistence-harvest patterns during offshore pipeline construction could affect birds who concentrate around the construction site and equipment and the physical presence of vessels, aircraft and construction equipment in the offshore and onshore environments. Vessels could become obstacles for birds and can be anticipated to be utilized during offshore pipeline construction. These additional vessels could result in further disturbance to marine mammals and fish during harvest seasons.

The onshore pipeline would affect subsistence during the active construction periods and certain effects would continue for the operational life of the pipeline. The pipeline, over the life of the Scenario, will total 300 miles from the Chukchi Sea, across the NPR-A to Prudhoe Bay and connecting to the Trans-Alaska Pipeline System (TAPS). Onshore pipeline construction would occur during the winter, crossing subsistence resource habitats and hunting use areas which could affect the resources and access to the use areas. Shorebase and supply boat terminal construction activities and disturbance will remain the same as for the exploration phase.

The potential for small refined oil spills (<1,000 bbl) continues in the Exploration and Development period. These spills could occur during exploration as described above or during early development activities (i.e., facility construction and pipeline installations). Spills during this phase would come from similar sources having the same effects on resources as described and analyzed for the exploration phase. During this phase, nearshore oil-spill-recovery vessels would be moored in Kotzebue Sound and effects would be the same as for the exploration phase.

Conclusion. The exploration and development period of the Scenario involves the same activities as the exploration period along with development activities such as pipeline construction and installation activities offshore and onshore. If these activities reduce subsistence harvests, then public health effects and impacts to EJ would result. Overall, the activities conducted during this time period are anticipated to have a moderate impact on EJ if mitigation measures described in the subsistence section are taken. If mitigation measures are not enacted, effects could well be major.

Exploration, Development, and Production (Years 10-25)

This time period features the continuation of exploration and development activities as well as the start of production activities. Impacts from exploration and development activities would occur as analyzed in previous sections above. All activities related to this were analyzed in-depth in Sections 4.3.11, 4.3.12, and 4.3.13.

Exploration drilling continues during this period and impacts from that activity are included. Up to four drilling units will be operating at once and there will be new construction activity associated with platform installation. Meanwhile, oil and condensate production would commence, entailing the operation of OCS platforms and associated pipelines.

Small (<1,000 bbl) oil spills could occur during exploration, development, production, and decommissioning. Several hundred small oil spills are assumed to occur during the 77-year Scenario. In Year 10, as oil development and production begin in earnest, large (≥1,000 bbl) oil spills could occur. It is assumed that two large oil spills could occur during the entire life of oil development and oil production activities. In this phase, spills include refined hydrocarbon product and spills of crude oil, condensate, and diesel. Overall, the activities conducted during this time period are anticipated to have a moderate impact on EJ.

Small oil spills

Small oil spills during this phase include crude or condensate spills, diesel spills, or gas releases. Small oil spills are described in Section 4.1.2.5 and Tables 4-1 and 4-2 describe assumptions about small oil spills. These spills were also described in Sections 4.3.11, 4.3.12, and 4.3.13.

Small oil spills have the potential to impact subsistence harvest resources and impact public and community health if individuals contact oil through their food or environment. An oil spill of any volume into a river system or lake could have effects on a nearby community.

Large oil spills

Large spills, although accidental, have a varying chance of occurring. Large spills could occur from development and production activities and are likely to occur over the 74-year life of oil and gas development and production activities. Two large spills of crude, condensate or refined oil are assumed to occur during the development and production phase of oil and gas activities. The large spill sizes assumed are from a platform spill of 5,100 bbl for crude, diesel, or condensate oil and a pipeline spill of 1,700 bbl of crude or condensate oil. A large spill could occur at any time during the year and, depending on the time of year, a spill could reach the following environments: ice, broken ice, under ice, open water, shoreline, tundra, and snow. The oil weathering model simulates weathering after 30 days. Condensate and diesel oil will evaporate and disperse much more rapidly than crude oil, generally within 1-13 days. After 30 days in open water or broken ice, weathering for crude oil is assumed:

The effects of large oil spills on resources pertinent to EJ are analyzed in Sections 4.3.11, 4.3.12, and 4.3.13.

Conclusion

Effects would range from moderate to major, depending on impacts to subsistence harvests, and perceptions held by subsistence users regarding contamination that might involve avoidance of resource harvests and consumption.

Development and Production (Years 26-50)

Development and production activities during this period will continue in roughly the same manner and frequency as during the preceding phases analyzed above. This phase includes seismic surveys, construction of a satellite field and continuation of oil production. Construction activities would include installation of two additional production platforms and several offshore pipelines in Years 27-30. A gas pipeline, both offshore and onshore would be constructed. The construction and installation of these gas pipelines would occur parallel to the oil pipelines and would entail that same impacts as described above for oil pipelines.

Noise and disturbance impacts to subsistence harvest resources would be similar to those analyzed previously. There would be temporary, localized effects to offshore habitats from construction and placement of gas pipelines and suspension of sediments during offshore gas pipeline construction and placement, but these adverse effects would not persist across seasons. However, during this period, it would be anticipated that subsistence resources would become adapted to the ongoing activities in the Chukchi Sea.

Construction of an onshore gas pipeline would result in effects to terrestrial mammals used for subsistence. The installation of this pipeline adjacent to the oil pipeline could minimize effects to resources. Long-term access and maintenance could displace some terrestrial subsistence resources along this corridor.

Small refined and crude spills (<1,000 bbl) and large (≥1,000 bbl) crude, condensate, or diesel spills could occur during development and production. Two large spills are assumed to occur during the entire life of development and production. These spills are analyzed in previous phases and effects would be the same in this phase. The development and production of gas in Year 31 increases the chance of a large volume gas release. Gas releases could occur during development and production. Up to three gas releases were considered: one from a platform and two from an onshore pipeline.

Gas releases with or without explosion hazards in confined spaces could occur. This analysis estimates one 10 million cubic foot release occurs offshore from the facility and two 20 million cubic foot releases occur onshore from the 300 mi (483 km) gas pipeline. 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 would be short term (up to one day). Natural gas will weather and dissipate quickly in the atmosphere preventing widespread effects. 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.

Conclusion

Long-term effects from disturbance/displacement would now be observed. Overall, the activities conducted during this time period are anticipated to have a moderate to major impact on EJ, as an oil spill that resulted in affecting subsistence-harvest practices or consumption would have a disproportionate effect on the EJ population.

Production and Decommissioning (Years 51-77)

Production activities will have become routine by this period, although oil production will shift to gas production. No additional construction or seismic survey activities are anticipated. After both oil and gas resources are depleted facilities would begin to shutdown, wells plugged, and processing modules moved off the platforms. Decommissioning activities include; plugging and abandoning wells, decommissioning subsea pipelines, and removal of production equipment and platforms. Decommission of pipelines will occur during this phase and are flushed and cleaned, usually left in place, and then buried below the seafloor surface. Production equipment would be partly disassembled and then moved off the platform during the summer open-water season. This could affect subsistence harvest resources due to impacts described in the previous sections. Further, decommissioning activities could impact open-water subsistence hunts by causing deflection of resources or by making resources unavailable for harvest.

Small (<1,000 bbl) and large (≥1,000 bbl) crude, condensate, or diesel spills could occur until Year 53, when crude oil and natural gas liquid condensate production ends. Large diesel spills and gas releases could occur through Year 74. Refined small spills could occur through Year 77. Effects from these spills on subsistence-harvest patterns and access to hunting areas would experience the same impacts and analyzed in earlier sections.

Effects resulting from this phase are analyzed in Sections 4.3.11, 4.3.12, and 4.3.13.

Conclusion

This time period involves the same activities as the previous phase, but there would be no additional construction and drilling activity is intensified at the mid-point. Platforms will gradually be removed. Long-terms effects from platform and pipeline operation/maintenance would continue, but at a reduced level. Effects from disturbance/displacement along the 300 mi (483 km) oil/gas pipeline route would persist, but at a reduced level. The activities conducted during this time period are anticipated to have a moderate to major impact; although the overall level of activities decreases, there is potential for decommissioning activities to disrupt subsistence activities. Increased anthropogenic noise associated with decommissioning or transport of employees to perform decommissioning activities could have a major effect on subsistence harvests if specific mitigation measures are not employed as described in the Subsistence Section above.

Conclusion

For the proposes of this discussion, Alaska Native subsistence-based communities fall clearly under the EJ analysis requirement in EO 12898 based on racial/ethnic composition alone (NSB, 2012b).

Although there have been substantial social, economic, and technological changes in Iñupiat way of life, subsistence continues to be the central organizing value of Iñupiat sociocultural systems. Iñupiat continue to be socially, economically, and ideologically loyal to their subsistence heritage with substantial amounts of subsistence food sharing within and between communities, compromising important kin ties (Heinrich, 1963). Disruption of subsistence-harvest patterns could alter these cultural values and affect community social structure, resulting in adverse effects impacting EJ on this minority population.

Over the life of the Scenario, several IPFs could affect EJ. Many oil and gas activities can cause impacts to subsistence-harvest patterns, which could cause health impacts due to potential effects on subsistence. The greatest amount of effects could come from large oil spills and anthropogenic noise.

Anticipated effects from oil and gas activities to EJ could be up to major. The phases with the most overlapping activities and highest probability of spills – specifically the Exploration, Development, and Production phase (Years 10-25) and the Development and Production phase (Years 26-50) –

would cause the most impact to subsistence-harvest patterns and thus lead to the highest level of EJ impacts.

4.3.14.2. Alternative II – No Action

Under Alternative II, Lease Sale 193 would not be affirmed and no current leases would be available for further exploratory drilling or other oil and gas development within the Leased Area.Therefore, no disproportionate high, adverse effects would occur from Lease Sale 193.

4.3.14.3. Alternative III – Corridor I Deferral

Alternative III provides the largest deferral area of the action alternatives – a corridor approximately 60 miles (97 km) wide along the Chukchi Sea shoreline. If Alternative III were selected, the distance from the shore to many activities could be greater than under Alternatives I and IV. No exploration or development drilling or platform construction would occur within the corridor, although certain activities (i.e., installation of a pipeline extending from the leases outside the corridor to the shore) could occur there. Of the Lease Sale 193 leases, only five are within Corridor I.

The minimum distance from shore under Alternative III could be slightly greater for the following than under the other action alternatives: length of pipeline from a platform to shore; travel distances from vessels and aircraft; source of discharges, emissions and noise from drilling and platforms; and, potentially the source of a large offshore oil spill.

Impacts to Environmental Justice could be less under Alternative III than under the other action alternatives due to slightly fewer impacts to subsistence resources and harvest-patterns. Using the Impacts Scale in Section 4.2, the level of impacts under Alternative III would be consistent with the other action alternatives.

4.3.15. Archaeological Resources

4.3.15.1. Alternatives I and IV

4.3.15.1.1. Impact Producing Factors (IPF)

This section identifies the IPFs resulting from the oil and gas activities associated with the 77-year Scenario. IPFs are organized by phase of oil and gas activity (i.e. exploration, development, production, and decommissioning). IPFs which occur during multiple phases are addressed in the phase in which they first appear; these discussions are then referenced where applicable. Accidental spills, although not considered routine oil and gas activities, have the potential to occur during each phase of oil and gas activity. General impacts of small and large spills and are addressed as IPFs in the subsection where they have the potential to occur. The impacts of spills within the larger context of all other activities that occur during each period are analyzed in the subsection below, "Impacts of the Scenario through Time."

Any offshore activity that disturbs the seafloor of the Chukchi Sea has the potential to affect archaeological and historic resources. (USDOI, MMS, 2007a). Areas having high-density ice gouging have been assumed to be of low potential for historic and prehistoric archaeological sites. This may be more apparent than real, since the "Jeremy Project," (so named after the primary investigator, undertaken in 1998 as a student project in collaboration with various Federal agencies), located the apparent remains of a wooden ship in an area of high density gouging. It should also be noted that although multiple lines of evidence indicate that this region had been occupied for approximately 10,000 years prior to the end of the Pleistocene (also known as "The Ice Age"), to date no archaeological sites have been discovered in the sub-seabed of what had been Beringia, the Land Bridge that linked the eastern coastline of Russia with the western coastline of Alaska (Hoffecker, Elias, and O'Rourke, 2014).

All of the following proposed activities involving ground disturbance would occur in the offshore:

- Geotechnical surveys
- Drilling of exploration wells
- Placement of platforms
- Installation of pipelines

These activities all have the potential to cause effects on prehistoric archaeological or historic resources eligible for listing on the U.S. National Register of Historic Places (NRHP).

Samples from coring could be analyzed for sea level and age-date information and archaeological remains, but drilling associated with exploration wells is destructive and damage to archaeological resources could result in rendering potential information irretrievable. The affected matrix would be disturbed or destroyed, with potential to impact buried prehistoric archaeological resources.

Exploration - Offshore

Discharges

Discharge of Muds and Cuttings

Discharging of drilling muds and cuttings directly on the seafloor could have an effect on submerged vessels (aircraft and shipwrecks), if present, by contamination during all phases.

Discharge of Graywater and Ballast Water

Discharge of graywater and ballast water directly in the water column in all phases could have an effect on submerged aircraft and shipwrecks, by contamination, if present.

Habitat Alteration

Ground Disturbance due to Geotechnical and Geological Surveys

Surveys involving coring have the potential to result in effects on resources. It is unlikely that geophysical surveys would affect historic and prehistoric archaeological sites, but they have the potential to identify them on the sea bed and anything buried under the surface of the sea bed. Good resolution of roughly the upper 30 m (100 ft) is crucial to identifying buried geological anomalies that may contain or comprise archaeological resources, including paleo-landforms, and other indicators of prehistoric archaeological sites.

The types of surveys are as follows:

Geotechnical Surveys

- Grab samplers
- Gravity or vibracores
- Rotary cores

Seismic Survey

- 2D Seismic from ship
- 3D Seismic from ship

Geohazard (Shallow Hazard) Survey

- Side scan sonar from ship
- Side scan sonar from ROV
- Multibeam echo sounder from ship

- Multibeam echo sounder from ROV
- Sub-bottom profiler from ship
  - Chirp or pinger
- Sub-bottom profiler from ROV
  - Chirp or pinger
- High-resolution multi-channel seismic
  - Sparker

Geological surveys, also referred to as geotechnical surveys, involve coring, which is generally conducted using a 31 cm (roughly equivalent to a one foot) diameter bit. Geological surveys result in ground disturbance that could both affect and identify buried prehistoric archaeological sites in all phases of the Scenario. Because geological surveys have the potential to result in impacts, drilling operations associated with coring shall be analyzed for archaeological remains.

Ground Disturbance due to Exploration Wells

As many as 40 wells could be drilled to explore and delineate prospects on leased blocks. This includes unsuccessful exploration wells on other prospects in the Chukchi Sea OCS, the drilling of which would be prompted by the first commercial discovery. Successful exploration and delineation wells would likely be decommissioned rather than converted to production wells because it would require several years before platforms and pipelines could be installed and the wells produced. Drilling and MODU stabilization (anchoring, setting spud cans) have the potential to affect historic and archaeological resources, if they are present in the area of potential effect. An archeological survey would be required prior to the issuance of a drilling permit.

Seafloor Alteration

Ground Disturbance due to Exploration Base

As stated in the 2007 FEIS, "Any onshore activity that removes or disturbs soil and/or causes shallow permafrost to thaw has the potential to disturb archaeological resources . . . from construction or from vandalism" (USDOI, MMS, 2007a). The following infrastructure construction could potentially affect archaeological resources:

- Exploration base (including housing facilities, mess halls, recreation)
- Air support base (including helipads)
- Search and rescue base
- Fuel tank farms
- Docks
- Marine ways
- Sanitation facilities or the expansion thereof
- Roads
- Material sources

Any other civil or environmental engineering projects necessary to support an exploration base could also affect archaeological resources.

Accidental Oil Spills

Small Refined Spills (<1,000 bbl, diesel)

Small Refined Spills (<1,000 bbl, diesel) have the potential to occur during Exploration activities and throughout the 77-year life of the Scenario. Impacts to historic and prehistoric archaeological resources from small oil spills were analyzed in the 2007 FEIS (Section IV.C.1.n(1)(a)). Small spills are generally into containment structures not reaching the environment, and cleaned up immediately. The types of potential effects from small oil spills are the same as the types of potential effects from large oils spills described below in the development phase.

Development – OCS

Physical Presence

Fill on the seabed for a Platform

Buried archaeological resources could be affected by compression from the platform, regardless of the design.

Fill on the seabed for Disposing of Excess Spoils

Excess spoils are comprised of excavated seafloor materials. It is likely that excavation of the seabed would occur in open-water season. Excess spoils would be spread on the seafloor adjacent to the excavation, and could affect historic resources. Excess spoils could result from pipeline and well cellar excavation for both oil and gas.

Discharges

Drilling wastes

All waste products (drilling mud, rock cuttings, and produced water) for platform wells would be treated and then disposed of in service wells located on the production platforms. For the outlying subsea wells, drilling waste products could be barged to the coastal facility for treatment and disposal. The production slurry, oil, gas, and water, would be gathered on the platforms where gas and water would be separated and re-injected into the reservoir using service wells, as would treated well cuttings and mud wastes, and waste water from crew quarters on the platforms. Any unidentified buried archaeological site in the area of potential effect could be exposed to contamination although this is unlikely, since these are cased before injecting in a disposal well. Sites could also be affected by well drilling.

Seafloor Alteration

Ground Disturbance due to Drilling for Platform Construction

Drilling associated with development wells has the potential to have the potential to affect historic and archaeological resources, if they are present in the area of potential effect. An archeological survey would be required prior to the issuance of a drilling permit. During the development phase, platforms would be constructed that may be pinned to the seafloor. The excavations for securing the platforms with “pins” would penetrate the seabed, and have the potential to affect buried archaeological resources.

Ground Disturbance due to Drilling from Platform

Damage to archaeological resources, if any are present, from drilling associated with development would result in irretrievable loss of any potential archeological information, as has been previously described.

Ground Disturbance due to Drilling from Flowline and Pipeline Construction

Subsea wells would produce to a template, which would be tied back to a platform by a subsea flowline. Damage to archaeological resources, if any are present, from subsea wells and flowlines associated with development would result in irretrievable loss of any potential archeological information, as has been previously described.

Presumably a large amount of the excess spoils could be used to refill each trench, but material from other sources may be required to completely backfill and armor the lines.

Development – Onshore

Seafloor Alteration

Ground Disturbance due to Production

The production base would support offshore work and then serve as the connection point for the trunk pipelines from the hub platform and the pipeline across the National Petroleum Reserve in Alaska (NPR-A). The production base would likely continue to be occupied throughout the length of time of the Scenario. Features of the production base include:

- Production base – additional processing
- Supply boat terminal
- Waste facility
- Pump station
- Fuel tank farms
- Docks
- Marine ways
- Sanitation facilities or the expansion thereof
- Roads
- Material sources

Habitat Alteration

Ground Disturbance due to Pipeline

The Scenario envisions two pipelines, one for oil and one for gas, that would connect gas produced from the Leased Area with a gas pipeline (currently in the early planning stages) and oil produced from the Leased Area with the Trans-Alaska Pipeline (TAPS). The oil pipeline would be installed during the winter in the same year as platform construction and installation. It would be installed above ground on vertical supports.

When the gas is brought on line, the gas pipeline would be constructed parallel to the oil pipeline. Communication lines would be elevated parallel to the oil pipeline. It should be noted that the gas pipeline could be buried if soil conditions permit. It is likely that a road would parallel the pipeline route to facilitate inspection and repairs. Features include the following:

- Oil Pipeline Corridor
- Vertical supports
- Communication lines
- Pump stations (up to four)
- Roads
- Material sources

- Gas Pipeline Corridor

Accidental Oil Spills

Large (≥1,000 bbl) refined or crude oil spills

In addition to small refined spills, development activities carry the risk of large (≥1,000 bbl) refined or crude oil spills. Impacts to historic and prehistoric archaeological resources from large oil spills are analyzed in the 2007 FEIS (Section IV.C.1.n(2)(c)). Generally, potential effects from activities increase with the level of activities from the exploration through the development phase, although they may start to diminish during decommissioning. For onshore archaeological resources, the potential for effects increases with oil-spill size and associated cleanup operations.

Impacts of the Scenario through Time

This section provides analysis of impacts to historic and potential prehistoric archaeological resources as they occur throughout the 77 years of the Scenario. This analysis addresses the particular oil and gas activities that would occur during each relevant time period and analyzes their impacts against the backdrop of a dynamically affected environment. Whereas previous sections have focused on identifying relevant IPFs and the types of environmental impacts they may cause, this section more specifically accounts for the level at which each IPF occurs during a given phase, the overlap of IPFs, and any additive or synergistic impacts which may result. In total, these sections tell the story of how the activities comprising the Scenario would affect historic and potential prehistoric archaeological resources through time.

The National Historic Preservation Act of 1966 as amended (NHPA) and attendant Federal regulations that promulgate the NHPA, specifically 36 CFR 800, require that Federal agencies make reasonable and good faith efforts to identify historic properties within the area of potential from federally permitted, licensed, or funded onshore and offshore operations. Compliance with NHPA leads to:

- Identification of archaeological and historic resources
- Determination of eligibility for placement on the NHRP
- Assessment of adverse effects
- Resolution of adverse effects

Resolution of adverse effects may include measures to avoid, mitigate, or monitor the historic property in consultation with consulting parties (36 CFR 800). Additionally, relic geologic features representing localities that were optimal for archaeological human occupation or use, referred to as "paleo-landforms," are also considered by BOEM to be prehistoric archaeological resources. Identification measures would include surveys to identify historic and archaeological resources. Monitoring might be necessary to ensure that avoidance is undertaken in accordance with plans. Mitigation measures might include relocating infrastructure to avoid sites, or archaeological excavation (archaeological excavation of historic properties is considered to be an adverse effect).

NHPA requires that both effects to historic properties be considered. An example of a direct impact would be drilling through a buried archaeological site. An example of an indirect effect would be vandalism.

All of the activities described in the Scenario would require Federal approval and thus compliance with the NHPA and its implementing regulations. Identification of historic and prehistoric archaeological sites, the area of potential effect, mitigation, and monitoring measures would be accomplished in accordance with the NHPA and in consultation with the State Historic Preservation Office. Therefore, subsequent analysis of impacts in this section assumes the following mitigation measures:

To minimize the potential for effects to historic and prehistoric archaeological resources, OCS construction should be preceded by high-resolution geohazard surveys that acquire subsurface and seafloor data to identify historic archaeological resources and potential for prehistoric archaeological resources. The most effective practice would be through the use of high resolution 2D surveys with lane spacing of about 15 m (~50 ft) apart. The use of subbottom profilers, sidescans, magnetometers, and chirp sub-bottom profiler systems are the most effective technology, combined with procured data analysis by a qualified archaeologist, for identifying subbottom archaeological features including shell middens (Christopher Horrell, USDOI BSEE archaeologist, pers. comm. January 23, 2015). These data could serve as an effective identification and mitigation strategy. Ideally, these data would identify the majority of historic and archaeological resources, either onshore or offshore, before any activities are permitted. Geohazard high resolution geophysical surveys also have potential to identify sub-seabed and seafloor archaeological resources or features, including drowned aircraft or shipwrecks in all phases of the Scenario.

Geotechnical surveys and geohazard surveys performed in advance of exploration drilling are fundamental to providing information about historic and prehistoric archaeological resources, as long as they provide high resolution of the upper strata of the sub-seabed. This resolution is needed to readily distinguish anomalies that could comprise buried archaeological resources and features. If the resolution achieves this level of sufficiency of Holocene and Pleistocene depositions on seafloor and buried in the sub-seafloor, it would probably serve as a mitigation measure.

These high-resolution surveys could identify: (1) 2D images that display in high resolution topographic features between 30,000 and 15,000 years ago during the latter part of the Pleistocene; (2) sub-seafloor stratigraphy with clarity to identify anomalies and/or paleo-landforms that might represent archaeological resources or locations thereof; and (3) imaging of the sea-floor sufficient for identification of ship wrecks and aircraft remains. Resolution achieving this this level of sufficiency would serve as a mitigation measure throughout the life of the plan.

Mitigation to reduce potential impacts from exploration drilling, development, and production activities also includes analysis of rotary cores for archaeological remains and other related properties such as sediment age and depositional setting. Organic material would include shell, wood, bone, antler, ivory, and charcoal, DNA, and enzymes. Sediment collection, analysis, and dating associated with organic bands also should be included. Sediment analysis includes assessment of particle size, magnetic susceptibility, loss on ignition, and mass density analysis. Currently, dating methods include radiocarbon dating (14C of wood and charcoal, and 12-13C of shell) and solid isotope analysis of sediments. An effective mitigation strategy would include a core dedicated to archaeological analysis. Best practices would meet or exceed those documented in the Statoil 2011 Archaeological Assessment (Rogers, 2012).

Although coring has the potential to affect buried archaeological resources, it can be viewed as an analytic tool for identifying archaeological resources, analogous to excavating test pits on land to locate archaeological resources. Any effect on a buried archaeological resource would be offset by its discovery and subsequent analysis. The discovery of an archaeological site within the area of potential effect from development would initiate the NHPA Sec. 106 process. First, the significance of the site would be assessed to determine eligibility for placement on the NRHP in consultation with consulting parties. In this case, consulting parties, as defined by 36 CFR 800 could include the Federal agency official, the Advisory Council on Historic Preservation, the State Historic Preservation Officer, federally recognized tribe, ANCSA regional corporation, ANCSA village corporation, local governments, and applicant. It is reasonable to assume that any archaeological site found buried below the seafloor of the Chukchi Sea would be considered eligible for placement on the NRHP because it would be associated with Beringian occupation. Next would include determination of effect of the Proposed Action. If the action were determined to be an adverse effect, mitigation methods would be developed. One outcome might be a realignment of planned activities to avoid the area of potential effect on the historic property; another might include excavation and analysis in accordance with NHPA.

Thus, although drilling and seafloor penetration or disturbances from MODUs, drilling, platform placement, or pipeline installation all have the potential to destroy any cultural resources that they contact, in actuality, the chances of inadvertent impacts would be greatly reduced because the undertaking would be preceded by geophysical and geotechnical surveys. This finding would be predicated upon the thorough archaeological analysis of the data, as described herein, for compliance with NHPA.

In the 2011 SEIS (Appendix A), BOEM acknowledged that it does not possess complete information on the existence or location of unknown archaeological resources. This "missing" information is "relevant to reasonably foreseeable significant adverse effects" given the possibility that the exploration phase activities could irreversibly damage currently unknown sites, which would constitute a significant adverse effect. This "missing" information, however, is not "essential for a reasoned choice among alternatives." Potential impacts to archaeological resources are similar among all alternatives given that ground disturbance would occur even in Alternative II, the No Action Alternative, and that pipelines would in the other alternatives use the same oil infrastructure corridor; additional information on the location of archaeological resources would be gathered through required preconstruction surveys and used to avoid or minimize impacts during development and production. Section 106 would apply regardless of which alternative is selected, and every alternative has the potential to result in adverse effects on archaeological or historic non-renewable resources. The 2011 SEIS (Section IV.C.16) 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." This statement is also applicable to the Second SEIS. 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 Second SEIS fully complies with 40 CFR 1502.22.

Exploration (Years 1-5)

Exploration includes those activities conducted to acquire information about the location, size, and characteristics of oil and gas prospects within the area of leasing. This includes activities conducted to acquire information about potential drilling locations, e.g. seafloor characteristics and/or drilling hazards. This also includes exploration and delineation well drilling. More specifically, these activities include:

OCS Geohazard surveys (three surveys over five years)

Geohazard surveys would be unlikely to adversely affect historic and potential prehistoric archaeological resources, but as previously described, they have the potential to identify and delineate historic and prehistoric archaeological resources on the seafloor or subsurface as well as buried archaeological resource potentials.

Geotechnical Surveys (three surveys over five years)

These surveys involving coring do have the potential to both locate buried archaeological resources and cause adverse effects to buried archaeological resources. Geotechnical surveys involving coring have the potential to impact historic and prehistoric archaeological resources. Each rotary bore hole would affect roughly 233 m^3 (8,000 ft^3) of soil below the seabed that might contain archaeological material. If the upper 30 m (98 ft) of the borehole (conservatively) is considered to be suitable for analysis.

Exploration and delineation well drilling (12 wells over five years)

A total of up to 10,681 m^3 (≤400,000 ft^3) of soil would be excavated that might contain archaeological material, assuming that any object or artifact associated with human occupation and use of Beringia would be found in the upper 30 m (~100 ft) of soil.

Current technology provides three methods of drilling exploration wells from MODUs. The first uses a drill ship. The drill ship must be anchored in place to provide stability for drilling. The anchoring area of disturbance per well associated with a drill ship would range to 2,755m^2 – 5,510 m^2 (~30,000 ft^2 – 60,000 ft^2) per well. The surface area of disturbance from a drill ship (including the 20-anchor array field) would be about 95 m^2 (roughly 1,000 ft^2). The depth at which the anchors would sink would vary depending upon the matrix but would have the potential to affect historic or prehistoric archaeological resources.

The second methodology uses a jack-up rig. A jack-up rig has three and sometimes four support legs. The legs are supported on the seafloor by mats or spud cans. Each mat or spud can is approximately 15 m (50 ft) in diameter. Each jack-up rig elevated on spud cans would disturb an area of roughly 547 m^2 (roughly 6,200 ft^2). The depth to which the spud-can would penetrate the seabed would vary depending upon the matrix, and is unknown, but has the potential to cause adverse effects to historic and prehistoric archaeological resources. When either a drill ship or a jack-up rig drills a well cellar, the area subject to disturbance would be as much as 284 m^2 (roughly 3,000 ft^2).The depth to which the spud-can would penetrate the seabed would vary depending upon the matrix, and is unknown, but has the potential to cause adverse effects to historic and prehistoric archaeological resources.

The third methodology uses a semisubmersible. A semisubmersible would not touch the seafloor, although the anchor array and drill would roughly be equivalent to a drill ship, and both have the potential to affect archaeological resources.

Drilling associated with wells during both the exploration and development phases is destructive and results in irretrievable impacts. A 6 m to 12 m diameter (~20-40 ft) drill would result in the disturbance of 933-3,700 m^3 (~33,000–130,600 ft^3) assuming the upper 30 m (~100 ft) has the potential to contain any archaeological resources. Drilling has the potential to result in irretrievable loss of contextual information of buried historic and prehistoric archaeological resources because it would remove the affected matrix.

Exploration drilling would be conducted by jack-up rigs, drill ships, or submersibles. It is unlikely that semisubmersibles would be utilized during the exploration phase, but they have the potential to impact an equivalent amount of the seabed to a drill ship due to the anchor array. Thus, assuming that only jack-up rigs and drill ships would be for used for drilling the 12 wells during the exploration phase, the maximum quantity of seabed disturbance would equate to about 570 m^2 (~6,135 ft^2).

It is unlikely that buried archaeological resources would be impacted if archaeological work has been completed during the exploration phase. Neither fill nor a pinned platform would impact shipwrecks or other cultural resources present on the sea bed because geohazard (shallow hazard) surveys conducted during the exploration phase would have identified them and appropriate mitigation measures, including avoidance, would have been negotiated in accordance with the NHPA.

Small refined oil spill

Small refined spills (<1,000 bbl) could occur during exploration activities as shown in Tables 4-1 and 4-2. These spills could be a result of refueling or spillage of hydraulic fluids or machine oils during geological and geophysical activities. The estimated geological and geophysical spills range from <1 to up to 13 bbl. A fuel spill would introduce hydrocarbons and be confined to the surface water. Effects of refueling at a dock might result in oiling of the shore. Other effects to historic or archaeological resources might be attributable to excavation to remove oiled soil or vandalism of resources by workers during oil-spill cleanup. The numbers of sites that would be impacted is unknown and cannot be quantified at this time. The spillage would weather within hours or a few days, depending upon the size of the spill. The effects would be localized and short term, negligible and minor unless organic archaeological material is oiled. It is not likely that any small refined oil spill offshore would affect archaeological or historic resources as they would occur at sea at least 25 m (≥82 ft) from shore, booms would be placed prior to refueling, and spillage would be unlikely to sink to the bottom or be carried to the intertidal zone.

Exploration activities include refueling drilling rigs and support vessels. Refueling also has the potential for a small spill of approximately 50 bbl or less. These activities typically have a fuel transfer plan is in place for these activities. Exploration well drilling could involve storage of a barge with safety equipment in Goodhope Bay, (the water body that defines the north shore of the Seward Peninsula). Operators have indicated that the barge would be over 11 km (7 mi) from land in a water depth of approximately 9 m (30 ft). There is a low potential for any effects to historic resources from the planned moorings and staging in Goodhope Bay (Tobey, 2013). The moored vessel(s) would be refueled at least once during the drilling season, and a small spill of 50 bbl or less could occur. It is not likely that fuel spills related to a drillship would have an effect on archaeological or historic resources for the same reasons specified for geological and geophysical small fuel spills. However, it is conceivable that some spilled fuel in Goodhope Bay could reach the shoreline, affecting the intertidal zone and any cultural resources, such as shipwrecks, in the intertidal zone could be impacted. If this were the case, it would constitute a major effect.

Onshore

Construction of exploration base (one base over first two years)

The exploration base would likely be constructed within the roughly 15 acres (6 ha) that would later be used for the production base. The 15-acre estimate is limited to only the camp. Environmental health components (water and wastewater treatment facilities, landfill, and other similar infrastructure) may or may not be in addition to the 15 acres needed for the exploration base. To minimize impacts to historic and prehistoric archaeological resources, an effective mitigation strategy would include archaeological surveys of all onshore ground disturbance associated with these activities. As stated in the 2007 FEIS, “Any onshore activity that removes or disturbs soil and/or causes shallow permafrost to thaw has the potential to disturb archaeological resources . . . from construction or from vandalism” (USDOI, MMS, 2007a).

Construction of air support base (one base over first two years)

If the exploration base is constructed contiguous to Wainwright or Barrow, it is estimated that an extension of the airstrips in these communities would be needed to accommodate transport aircraft and larger passenger aircraft. An estimate of up to roughly 5 acres would be required to enlarge the airstrip.

Construction of search and rescue base (one base over two years)

Similarly, the Proposed Action would likely require an archaeological survey during the early planning stages. For the purpose of this analysis it is assumed that special geoengineering techniques would optimally address maintaining permafrost, as any activity that removes or disturbs soil and/or causes shallow permafrost to thaw has the potential to disturb archaeological resources.

Construction of a production base (construction to start in fifth year)

The production base would likely be contained within the 15 acres (6 ha) footprint of the exploration base. Special geoengineering techniques would optimally address maintaining permafrost, as any activity that removes or disturbs soil and/or causes shallow permafrost to thaw the potential to disturb archaeological resources.

Additional construction

Installation of primary pad for pump station, landfall valve pad, pigging facilities, and land-farm for barged wasted disposal is estimated to total approximately 60 acres. The proposed footprint of each of these would also likely require an archaeological survey during the early planning stages.

At least one mi (1.6 km) of road would need to be constructed, and would equate to an additional roughly 5 acres of land that would require an archaeological review during the early planning stages.

At least three gravel mine resources to provide material for pads, roads, and fill for offshore installations are conservatively estimated to affect an estimated 250 acres of land. These resources would need to undergo the Sec. 106 archaeological survey and review process during the early planning stages.

Construction of a supply boat terminal (construction to start in fifth year)

At least 10 acres of uplands would undergo disturbance for the construction of the supply boat terminal. As with other anticipated onshore installations, any associated ground disturbance has the potential to effect historic and prehistoric archaeological resources.

Conclusion: Archeological Impacts during the Exploration Phase

The impacts that would occur during the exploration phase are difficult to estimate because the total number of resources is unknown, but there is the potential that these activities could result in adverse effects. Given the relatively higher amount of seabed and subsurface disturbance associated with geotechnical and geological drilling; as well as exploration drilling, the presence of MODUs, and the wider breadth of disturbance, collectively these activities would have higher impacts on historic and prehistoric archaeological resources properties than experienced previously in the Chukchi Sea.

The impacts from these activities could affect historic and prehistoric archaeological resources both on land and at sea. There is potential for these disturbance activities to cause additive impacts through drilling multiple wells in the same locale on multiple occasions, i.e. during the exploration phase and again during development.

Overall, the Exploration Phase activities have the potential to cause a major effect on historic and prehistoric archaeological resources because seafloor penetration would have the potential to result in adverse effect of a prehistoric archaeological site, if one is encountered. There is even greater potential for disturbance if the drilling activities were to encounter an aggregation of shipwrecks. For example, if actions encounter the lost fleet of 1871 or the lost fleet of 1876, the undertaking would result in adverse effects on historic shipwrecks. The potential for such impacts would be reduced, resulting in negligible to minimal effects to archaeological resources, should comprehensive, high-resolution archaeological surveys be conducted prior to any seafloor- or ground-disturbing activities, thereby alerting project proponents and Federal regulators of the presence of archaeological resources and facilitating avoidance.

Exploration and Development (Years 6-9)

During this period, exploration activities would continue, and development activities would commence. The exploration activities that would continue to cause the IPFs analyzed above, (i.e.

ground disturbance), include geotechnical seismic surveys, exploration and delineation well drilling, offshore exploration platforms, small oil spills, and onshore construction.

Development includes those activities conducted to create the infrastructure necessary for production. This period features more overlapping and diverse activities than the exploration-only period. More specifically, these activities include:

- **Geohazard survey (one over four years).** This undertaking would be the same as described in the exploration phase.
- **Geotechnical survey (one over four years).** This undertaking would be the same as described in the exploration phase.
- **Production well drilling (three wells over four years).** This undertaking would be the same as described in the exploration phase.
- **Exploration and Delineation and Service well drilling (16 wells over four years).** This undertaking would be the same as described in the exploration phase.
- **Installation of offshore platform (one platform over four years).** The platforms that would be installed in the Leased Area have no analogue and their design remains conceptual. They would likely be a circular shape, but the radii are unknown at this time. A full analysis would be completed for public review and comment prior to agency approval of a Development and Production Plan. The platform and its installation have the potential to cause adverse effects on cultural resources. The first platform would be the hub, connecting pipelines from other platforms to the main pipelines to shore. Presumably this would include one pipeline for oil and another pipeline for gas. On-Platform and Production Service wells (three wells over four years). This undertaking would be the same as described for delineation and service well drilling during the exploration phase.
- **Installation of offshore oil pipeline (160 mi over four years).** At least 257.50 km (≥160 mi) each of oil and gas pipelines are projected for burial in the seafloor. The width of the offshore pipeline trenches is estimated to be approximately 3 m (~10 ft) and the depth is estimated to be 3.5 m (~11.5 ft), hence about 2 million m^3 (~81 million ft^3) of seafloor would be affected. Effective mitigation measures for effects on historic and archaeological resources are described under the subsection, "Impacts of the Scenario through Time."
- **Installation of an onshore oil pipeline (300-320 miles over 4 years).** The onshore oil pipeline would stretch about 483 km (~300 mi) across the NPR-A to Prudhoe Bay. As many as three pump stations would be required at specific intervals along its length and would likely be collocated with oil fields along the corridor. They would be outside of the approximately 31 m (~300 ft) wide pipeline corridor, and are described below. An effective mitigation strategy would involve a systematic archaeological survey of the pipeline right-of-way with particular attention to the proposed vertical support locations.

Vertical support members for pipelines displace vegetation and disturb a zone with a radius of around 0.5 m (1.6 ft), resulting from the overburden deposited around the structure as well as from thermokarst (USDOI, BLM, 2012).

- **Installation of up to three pump stations along the route.** The Scenario describes installation of up to three pump stations along the pipeline route. Up to approximately 50 acres could be required for each pump station, for a total of up to approximately 150 acres that would be used as pump stations.

- **Construction of production base (1)**.
- **Construction of a processing facility (1).** This undertaking would be the same as described in the exploration phase.
- **Construction of a waste facility (1).** This undertaking would be the same as described in the exploration phase.

Small Spills Offshore and Onshore.

Small refined spills have the potential to occur during the Exploration and Development phase of the Scenario, and in conjunction with geological and geophysical surveys, exploration drilling, moorage of barge with safety equipment in Goodhope Bay, and initial development activities including facility construction and pipeline installations. Spill characteristics and effects would be consistent with those described for small oil spills during the Exploration Phase. More in-depth information on small oil spill characteristics is found in Section 4.1.2.5.

Conclusion: Archeological Impacts during Exploration

The impacts from these activities could affect historic and prehistoric archaeological resources both on land and at sea. Although all of the Exploration and Development phase activities to occur during this period are limited in duration, there is potential for these disturbance activities to cause additive impacts through multiple wells.

BOEM has determined that this Exploration and Development period would cause the greatest level of impacts to historic and prehistoric archaeological resources than any other phase comprising this Scenario. This is due to the installation of the offshore and onshore oil pipelines, continued exploration activities, and installation of platforms. If mitigation measures described herein are not followed, the overlapping activities could lead to a major impact during this phase if historic or archaeological sites are present and are impacted.

The impacts that would occur during the Exploration and Development phase is difficult to estimate because the total number of resources is unknown. Given the higher amount of excavations added to ground disturbance that occurred during the exploration phase, installation of offshore platforms and pipelines and the onshore pipeline, collectively these activities would have the highest level of ground disturbance and the greatest potential effects on historic and prehistoric archaeological resources of any other phase during the 77-year period under consideration.

All of the undertakings described in the Scenario would necessitate compliance with Sec. 106 during the early planning stages to avoid or mitigate any historic and prehistoric archaeological resources identified along the route. For instance, installation of offshore platforms should be preceded by high resolution seismic work and coring sufficient to allow identification of buried anomalies that might contain or represent a potential archaeological resources. An effective mitigation measure would include completion of archaeological reports that would contain all of the data analyses as described above; adherence to this mitigation measure would reduce impacts to a lesser level than major, based on consultation with the SHPO.

Onshore, to minimize potential impacts, archaeological surveys of the pipeline corridor during summer months would need to precede pipeline construction (USDOI, MMS, 2007a). Further, special geoengineering techniques would optimally address maintaining permafrost as any activity that removes or disturbs soil and/or causes shallow permafrost to thaw has the potential to disturb archaeological resources.

Overall, Exploration and Development Phase activities have the potential to cause a major impact on historic and prehistoric archaeological resources, assuming that historic and prehistoric archaeological resources are identified in areas of the Proposed Action and one or more would be adversely impacted.

Exploration, Development, and Production (Years 10-25)

During this period, exploration and development activities would continue, and production activities would commence. The exploration activities that would cause IPFs analyzed above include ground disturbance, include some geotechnical rotary coring, exploration and delineation well drilling, and construction. Small or large refined oil spills could also occur. Development includes those activities conducted to create the infrastructure necessary for production. More specifically, these activities include:

- **Geohazard seismic survey for exploration and development (seven over 14 years).** This undertaking would be the same as described for geohazard surveys during the Development phase.
- **Geotechnical survey for exploration and development (seven over 14 years).** This undertaking would be the same as described for geotechnical surveys during the Development phase.
- **Exploration/delineation wells (12 over 14 years).** This undertaking would be the same as described for exploration and delineation wells during the Development phase.
- **On-platform and service wells (307 over 14 years).** This undertaking would be the same as described for on-platform and service wells during the Exploration phase.
- **Installation of OCS platforms (5 over 14 years).** This undertaking would be the same as described for installation of offshore platforms during the Exploration phase.
- **Production and service well drilling (48 over 14 years).** This undertaking would be the same as described for production and service well drilling during the Exploration phase, though in this portion of the Scenario up to four drilling units will be operating at once.
- **Installation of subsea wells (90 over 14 years).** The Scenario explained that the installation of subsea wells would involve drilling the well, and then directional drilling below the seabed to connect the subsea well with a directionally drilled pipeline to the offshore platform. There would be approximately 48 km (30 miles) of subsea flowlines to each host platform. With a total of five host platforms, this equates to 240 km (approximately 150 miles) total of subsea flowlines for oil. Commercially produced gas would require separate flowlines, so during the development phase, up to 480 km (roughly 300 miles) of total subsea flowlines would be constructed to the host platforms. Potential impacts associated with ground disturbance are as described in the exploration phase, "IPF Habitat Alteration (Ground Disturbance)."

There would be no onshore activities associated with this phase.

Accidental Oil Spills. Tables 4-1, 4-2 and 4-3 provide more in-depth information on oil-spill characteristics. This section adds refined spills from the full development and production activities (approximately 6 per year averaging 3 bbl each). This section also introduces the analysis of small hydrocarbon (crude/condensate) spills (approximately 5 per year) and the two small crude oil spills >500 bbl and <1,000 bbl. Of those two small crude oils spills (700 bbl), one is assumed to occur offshore, and one is assumed to occur from the 300 mi (483 km) onshore pipeline. This section introduces the full analysis of the assumed two large oil (crude, condensate or diesel) spills.

Small Oil Spills. The small crude or condensate spills could adversely affect any shipwrecks or terrestrial surface sites through contamination from oiling. Small refined spills have the potential to occur during the Exploration, Development, and Production phase of the Scenario, Small spills might occur in conjunction with geological and geophysical surveys, moorage of barge with safety equipment in Goodhope Bay, and refined spills from the full development and production. Refined spill characteristics and effects would be consistent with those described for small oil spills during the Exploration Phase.

Large Oil Spills. Two large spills of crude, condensate, or diesel if fuel might occur storage of diesel is incorporated on the platforms. In the event of a large oil spill, potential effects would be from oiling of archaeological resources, disturbance or destruction from activities associated with oil-spill response and cleanup operations in the event that a large spill occurs, and vandalism. It is difficult to prioritize any areas of the Chukchi Sea and coastline as more important for archaeological resources, because cultural resources that were documented in the Alaska Heritage Resource File (AHRS, 2014) are found in every land segment but one from the Canadian Border to just south of Point Hope (LS 111-40). To add the complexity, very few systematic archaeological surveys have been performed along the coast, so there may be a number of additional undocumented archaeological and historic resources.

The Exxon Valdez Oil-spill (EVOS) event demonstrated that potential impacts increase as coastal spill response and cleanup activities increase. A hypothetical spill(s) which affects larger areas of the coastline may in this sense pose more potential for significant impacts to archaeological resources. In the event that a large oil spill occurred during the open-water season, or during winter and melted out of the ice during spring, some historic and archaeological resources in coastal land segments could be directly exposed to and contaminated by the spill along the beaches and in shallow waters during periods the open-water season. If a large oil well blowout occurred in an area where surface or near-surface cultural resources were present, the resources would probably be destroyed or rendered scientifically valueless either by the blowout or the subsequent cleanup and remediation procedures that followed. Contamination by oil would make radiocarbon dating of that site impossible because spilled oil would seep into charcoal, bone, wood, or other organic materials at the site that would be used for radiocarbon dating, and contaminate them so that their true dates could no longer be accurately determined (USDOI, BOEMRE, 2011a; USDOI, BLM, 2012).

For onshore archaeological resources, the potential for effects increases with oil-spill size and associated cleanup operations. For purpose of analysis, the weathering characteristics of the assumed 1,700 bbl oil spill in summer and during meltout are shown in Tables A.1-4, A.1-5, and A.1-7, respectively.

Conditional Probabilities. This section discusses the chance that a large oil spill(s) from the Leased Area could contact specific LSs that are important to archaeological and historic resources, assuming a hypothetical large spill(s) occurs. The OSRA model estimates the chance of a large spill originating from LAs or PLs contacting LSs during summer or winter where cultural resources have been identified or reported. Cultural resources documented in the Alaska Heritage Resource File (AHRS, 2014) are found in all nearly all of the land segments from the Canadian Border to just south of Point Hope (LS 111-40).

Large Spills Summer. The OSRA model estimates the chance of a large spill from LAs and PLs contacting individual LSs 64-88 (Point Hope – Cape Simpson, Piasuk River) within 30 days, 180 days, and 360 days ranges from <0.5-10% (Tables A.2-32, A.2-34, and A-2-36). The higher percentages are associated with a large spill originating from a nearshore pipeline.

Large Spills Winter. The OSRA model estimates the chance of a large spill from LAs and PLs contacting individual LSs 64-88 within 30 days, 180 days, and 360 days ranges from <0.5-4% (Tables A.2-57, A.2-59, A.2-60).

Combined Probabilities. The chance of one or more large spills occurring and contacting LSs containing known and reported cultural resources (LSs 64-85) is <0.5-3% within 30 days, and 1-4% within 180 and 360 days (Tables A.2-74).

Oil-Spill Response. Various aspects of a large oil-spill response and cleanup have some potential to adversely affect archaeological and historic resources.

Vessel anchoring arrays 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, 2011a). Further, increased human presence can result in vandalism of archaeological and historic resources by cleanup crews.

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; USDOI, BOEMRE, 2011a). This finding was affirmed by two studies of intertidal disturbance associated with the Exxon Valdez Oil Spill; they found that less than 2.3-2.4% of the sites in the area suffered damage (Mobley et al., 1990; Wooley and Haggarty, 1993). Although 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).

Conclusion: Archeological Impacts from Exploration, Development and Production

The impacts that would occur during the Exploration, Development, and Production period are difficult to assess because the total number of resources is unknown. A large number of wells would be drilled, and over half of the platforms associated with the Scenario would be installed, but overall, activities are not considered to be as great as during the previous phase since onshore construction and offshore pipeline trenching would be completed. The directional drilling for installation of subsea pipelines is of concern from an archaeological perspective, since all disturbance would occur below the seafloor, increasing chances that any discovery would remain undetected. Given the higher amount of excavations additive to ground disturbance that occurred during previous phases, installation of subsea wells collectively would have a high level of ground disturbance during the 77-year period under consideration, as noted above. The impacts of the activities could affect historic and prehistoric potential archaeological resources. Effective mitigation measures have been described above and would reduce impacts to less than major.

Overall, the Exploration, Development, and Production period phase has the potential to cause a major impact on historic and areas of potential prehistoric archaeological resources, if they receive adverse impacts from ground disturbance.

Development and Production (Years 26-50)

Activities during are the same as described for the Exploration phase. Effective mitigation measures have been described in under the subsection, “Impacts of the Scenario through Time.” Activities include:

- Geohazard seismic survey for exploration and development (1 over 24 years).
- Geotechnical seismic survey for exploration and development (1 over 24 years).
- Installation of offshore platforms (2 over 24 years).
- Production and service well drilling (149 over 24 years).
- Installation of offshore oil pipeline (5 miles over 24 years).
- Installation of offshore gas pipelines (210 miles over 24 years).

Onshore

Installation of onshore gas pipeline (300 miles over 24 years). The onshore gas pipeline would be constructed during the winter and stretch about 483 km (approx. 300 mi) across the NPR-A to

Prudhoe Bay. The gas pipeline is anticipated to range from about 97 to 127 cm (approx. 38 to 50 in) in diameter buried in a trench approximately 3 m (~12 ft) wide and about 3 m (~10 ft) deep. It would be buried within the approximately 31 m (~300 ft) wide pipeline corridor. It is anticipated that construction would be facilitated through the installation of either an ice road or a permanent access road that would be up to 12 m (~35 ft) wide paralleling the trench and impacting approximately 540 ha (~1,300 acres). An effective mitigation strategy would involve a systematic archaeological survey of the gas pipeline and associated road during the summer months and would reduce impacts to less than major.

Offshore and Onshore

Small or Large Oil Spills

Small and large refined, crude or condensate spills have the potential to occur during the Development and Production phase of the Scenario. Small spills might occur in conjunction with one geological and geophysical survey, moorage of barge with safety equipment in Goodhope Bay, and refined spills from the full development and production activities (approximately six per year averaging 3 bbl each). Small hydrocarbon (crude/condensate) spills and small crude oil spills, >500 bbl and <1,000 bbl might occur, one offshore and the other from the 300 mi (483 km) onshore pipeline. Spill characteristics and effects would be consistent with those described for small oil spills during the Exploration Phase. Two large spills of crude, condensate, or diesel might occur if fuel storage for diesel is incorporated on the platforms. More in-depth information on small oil-spill characteristics is found in Section 4.1.2.5.

Gas Releases

The development and production of sales gas in Year 31 raises the potential for gas releases, which could occur during development and production. Up to three gas releases were considered: one from a platform and two from an onshore pipeline. Because gas dissipates through evaporation, these releases would be unlikely to have effects on archaeological or historic resources unless ignition occurs. Ignition, resulting in an explosion and fire, would have potential to adversely affect cultural resources. If a large gas blowout ignited in an area where surface or near-surface cultural resources were present, the resources would probably be destroyed or rendered scientifically valueless either by the blowout or the subsequent cleanup and remediation procedures that followed. 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 affected by fire (USDOI, BOEMRE, 2011a). The potential for impacts to any adjacent shipwrecks is high. Fire would make radiocarbon dating of that site impossible. The burning or charring of charcoal, bone, wood, or other organic materials at the site that would be used for radiocarbon dating would render them useless for accurately determining their true age (USDOI, BOEMRE, 2011a; USDOI, BLM, 2012).

Conclusion Archeological Impacts during Development and Production

Disturbances from both Development and Production activities, could cause an equivalent level of impacts to historic and prehistoric archaeological resources to those experienced under the Exploration and Development phase, because the installation of offshore and onshore gas pipelines occurs during this phase. The overlapping activities could lead to a major impact during this phase.

The impacts that would occur during the Development and Production period are otherwise difficult to assess because the total number of resources is unknown. Given the higher amount of excavations additive to ground disturbance that occurred during previous phases, installation of gas pipelines collectively could have an equivalent impact as the earlier installation of the oil pipeline during the 77-year period under consideration.

The impacts from the activities could affect historic and prehistoric archaeological resources, if any are present in the area of ground disturbance. Overall, the activities of this period have the potential to cause a major impact on historic and prehistoric archaeological resources, given that sites occur and that one or more would be adversely impacted. If mitigation measures are adhered to, impacts would be reduced to less than major.

Production and Decommissioning (Years 51-77)

Activities during this period would be limited to Production, to include decommissioning.

- **Platform dismantling and removal from the area (21 rigs from Years 55-61).** Wells and associated pipelines would be permanently plugged with cement. Platforms would be disassembled and removed from the area. Removal of platforms is planned to occur in Years 60, 64, 67, 69 and 74, with the remainder being removed through Year 77. Impacts associated with the removal of platforms include ground disturbance.
- **Restoration of the seafloor.** Restoring areas of the seafloor at the end of the Production phase has the potential to result in adverse effects to historic and prehistoric archaeological resources.

Effects of Decommissioning. Decommissioning and reclamation of infrastructure would, under most circumstances, have limited, if any, impact on cultural resources. This statement is based the fact that any effects to cultural resources at the site being reclaimed probably occurred during the development and/or operation of the site. If previously non-impacted areas are encompassed by the decommissioning and reclamation activities, which would seem unlikely to occur as it is doubtful that reclamation would take place on previously undisturbed ground, then it is possible that impacts to undiscovered archaeological or historic resources could occur. Impacts could also occur on sites not previously identified (USDOI, BLM, 2012).

Accidental Spills. Large and small refined crude and condensate spill and gas release characteristics and effects would be consistent with those described for all the previous phases analyzed in this section.

Conclusion - Archeological Impacts during Production and Decomissioning

The Production phase is characterized by two events, the first being total conversion of extracting oil to extracting gas, and the second being actions related to decommissioning, including seafloor restoration. The Production phase appears to have the least potential of any previous phase to affect historic and potential prehistoric archaeological resources. Even so, activities associated with decommissioning platforms and seabed restoration have the potential to result in adverse effects on historic and prehistoric archaeological resources.

The impacts that would occur during the Production/Decommissioning Phase are difficult to assess because the total number of resources is unknown. However, all of the proposed activities during this period are limited in duration, though there is potential for these disturbance activities to cause additive impacts through repeated disturbance. As an example, if a platform were to be constructed in a manner that would cause ground disturbance, decommissioning and removal of the platform could potentially result in an additive disturbance.

Effective mitigation measures would include archaeological surveys using state-of-the-art technology prior to removal. It is not possible to predict what this technology might involve, although it is safe to assume that technology would have advanced beyond that used in the first decades of the second millennium. Future archaeological surveys may well identify historic and prehistoric archaeological resources in the area of potential effect that current technology is incapable of identifying.

Because decommissioning would begin over 50 years after the advent of exploration, it is important that state-of-the-art technology be used again to identify archaeological resources prior to ground disturbance, either at land or at sea because improvements in technology could result in better identification of historic and archaeological resources. It is also important that infrastructure 50 years old or older be evaluated against NRHP criteria to determine eligibility. The legal obligations may have changed during the period between exploration and decommissioning, and it is important that there is compliance with historic preservation laws and regulations in effect during this phase. Presumably, all eight platforms would be removed. Although the potential for ground disturbance of historic and prehistoric archaeological resources is less than during the previous phases, it is likely that any impact to a submerged or sub-seabed historic property would have a major effect.

Conclusion

Anticipated impacts to historic and prehistoric archaeological resources from the Scenario are major, given that historic and archaeological resources would be present, difficult to identify, and directly affected by activities described in this section. The amount of ground disturbance, both on- and offshore, would be of a large magnitude and a long duration. This impact assessment is not altered in the event of a 5,500 or 1,700 bbl oil spill. Because so little of the coastline or interior in the area of potential effects has received any systematic archaeological or historic surveys, and because systematic offshore archaeological surveys in the Leased Area have not yet occurred, a more realistic assessment of effects is not possible to establish, lacking a better database. Instead, this section has performed an assessment of the Scenario in an attempt to describe the story through time, assuming that effects would be major if any historic or archaeological resource would be adversely affected with no prior mitigation or monitoring procedures in place. Any unanticipated discovery as this would be subject to further evaluation as to the cultural significance by a qualified professional archaeologist. The use of offshore seismic activity and geohazard surveys to identify sites is nascent at best, and it is assumed that industry and agencies will strive to reach the highest level of cooperation in historic and archaeological resource identification, mitigation, and monitoring efforts through providing imaging sufficient and tracks close enough to identify any anomalous feature. A second assumption is that through the entire Scenario, technological improvements will lead to better historic and archaeological resource assessments.

4.3.15.2. Alternative II – No Action

Under Alternative II, Lease Sale 193 would not be affirmed and no leases would be available for further exploratory drilling or for development within the Chukchi Sea Leased Area. Exploration activities such as seismic surveys, which are not tied to leases, would continue. Impacts to anomalies that might contain archaeological sites from geological and geophysical would continue. Impacts from exploratory drilling, pipeline route clearance, shallow hazard surveys, and activities related to on-lease exploration and production would not occur unless additional lease sales were held and leases issued at a later date. Selecting Alternative II would result in a lower level of impact to archaeological and historic resources, and would reduce impacts to archaeological resources from major to negligible.

4.3.15.3. Alternative III – Corridor I Deferral

Alternative III provides the largest deferral area of the action alternatives – a corridor approximately 60 miles (97 km) wide along the Chukchi Sea shoreline. If Alternative III were selected, the distance from the shore to many activities could be greater than under Alternatives I and IV. No exploration or development drilling or platform construction would occur within the corridor, although certain activities (i.e., installation of a pipeline extending from the leases outside the corridor to the shore) could occur there. Of the Lease Sale 193 leases, only five are within Corridor I.

The minimum distance from shore under Alternative III could be slightly greater for the following than under the other action alternatives: length of pipeline from a platform to shore; travel distances from vessels and aircraft; source of discharges, emissions and noise from drilling and platforms; and, potentially the source of a large OCS oil spill.

The effects of Alternative III could be slightly greater than under the other action alternatives, due to slightly more trenching for pipeline installation from offshore leases. Using the Impacts Scale in Section 4.2, the level of impacts under Alternative III would be consistent with the other action alternatives.

4.4. Very Large Oil Spills

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:

- This first part (Section 4.4) describes the hypothetical VLOS scenario by providing background and new information in light of the Deepwater Horizon event and explaining the specific parameters that characterize the hypothetical VLOS
- The second part (Section 4.5) analyzes potential environmental impacts that could occur in the event of such a VLOS in the Chukchi Sea.

4.4.1. Background

On April 20, 2010, an explosion and fire occurred aboard the Deepwater Horizon while the vessel was in the process of plugging a 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.

In the aftermath of Deepwater Horizon event, President Obama directed the Secretary of the Interior to identify new precautions, technologies, and procedures needed to improve safety of oil and gas development on the Outer Continental Shelf. At the same time, the Secretary directed BOEMRE to exercise its authority under the OCSLA to suspend certain drilling activities so the Bureau could (1) ensure that drilling operations similar to those that led to the Deepwater Horizon event could operate in a safe manner when drilling resumed, (2) ensure extensive spill response resources directed toward the spill would be available for other spill events, and (3) provide adequate time to obtain input for enhancing intervention and containment capability and promulgate regulations that address issues described in the Increased Safety Measures for Energy Development on the Outer Continental Shelf report (USDOI, 2010).

The Deepwater Horizon incident investigations provided numerous other recommendations detailed in reports including the National Oil-spill Commission (OSC) report; the National Academy of Engineering (NAE) and the National Research Council (NRC) report Macondo Well—Deepwater Horizon Blowout: Lessons for Improving Offshore Drilling Safety; the Deepwater Horizon Joint Investigation Team (JIT) Report consisting of the USCG's Report of Investigation into the Circumstances Surround the Explosion, Fire, Sinking, and Loss of Eleven Crew Members Aboard the mobile Offshore Drilling Unit Deepwater Horizon in the Gulf of Mexico; and USDOI's Report Regarding the Causes of the April 20, 2010 Macondo Well Blowout; the USCG Incident Specific Preparedness Review BP Deepwater Horizon Oil Spill; and the USDOI OCS Safety Oversight Board Report to the Secretary of the Interior Ken Salazar. All of the above listed reports are described in the Outer Continental Shelf, Oil and Gas Lease Program: 2012-2017, Final Programmatic Environmental Impact Statement (USDOI, BOEM, 2012). Also, regulatory reforms are described in the 2012-2017, Final Programmatic Environmental Impact. These reports and regulatory reforms are incorporated by reference (USDOI, BOEM, 2012, Section 4.3.3.3.4).

4.4.1.1. Ongoing Regulatory Reform and Government-Sponsored Research

In light of the Deepwater Horizon explosion, loss of life, oil spill, and response, the Federal Government, along with industry, increased their rules and safety measures related to oil-spill prevention, containment, and response. Additionally, the Federal Government and industry have increased their research and reform in response to the Deepwater Horizon explosion, oil spill, and response through government-funded research, industry-funded research, and joint partnerships.

BOEM and BSEE have instituted regulatory reforms in response to many of the recommendations expressed in the various reports prepared following the Deepwater Horizon explosion, oil spill, and response. To date, regulatory reform has included both prescriptive and performance-based regulation and guidance, as well as OCS safety and environmental protection requirements. The reforms strengthen the requirements for all aspects of OCS operations. Ongoing reform and research endeavors of BSEE to improve workplace safety and to strengthen oil-spill prevention, planning, containment, and response are described in the 2012-2017 Programmatic EIS (USDOI, BOEM, 2012).

4.4.1.1.1. Oil and Gas and Sulphur Operations on the Outer Continental Shelf–Increased Safety Measures for Energy Development on the Outer Continental Shelf.

Effective October 22, 2012, the Final Drilling Safety Rule refines the Interim Final Rule by addressing requirements for compliance with documents incorporated by reference (77 *FR* 50856, August 22, 2012). The Final Rule:

- Establishes new casing installation requirements
- Establishes new cementing requirements
- Requires independent third party verification of blind-shear ram capability
- Requires independent third party verification of subsea BOP stack compatibility
- Requires new casing and cementing integrity tests
- Establishes new requirements for subsea secondary BOP intervention
- Requires function testing for subsea secondary BOP intervention
- Requires documentation for BOP inspections and maintenance
- Requires a Registered Professional Engineer to certify casing and cementing requirements
- Establishes new requirements for specific well control training to include deepwater operations

This Final Rule changes the Interim Final Rule (IFR) in the following ways:

- Updates the incorporation by reference to the second edition of API Standard 65—Part 2, which was issued December 2010. This standard outlines the process for isolating potential flow zones during well construction. The new Standard 65—Part 2 enhances the description and classification of well control barriers, and defines testing requirements for cement to be considered a barrier.
- Revises requirements from the IFR on the installation of dual mechanical barriers in addition to cement for the final casing string (or liner if it is the final string), to prevent flow in the event of a failure in the cement. The Final Rule provides that, for the final casing string (or liner if it is the final string), an operator must install one mechanical barrier in addition to cement, to prevent flow in the event of a failure in the cement. The Final Rule also clarifies that float valves are not mechanical barriers.
- Revises 30 CFR § 250.423(c) to require the operator to perform a negative pressure test only on wells that use a subsea blowout preventer (BOP) stack or wells with a mudline suspension system instead of on all wells, as was provided in the IFR.
- Adds new 30 CFR § 250.451(j) stating that an operator must have two barriers in place before removing the BOP, and that the BSEE District Manager may require additional barriers.
- Extends the requirements for BOPs and well-control fluids to well completion, well-workover, and decommissioning operations under Subpart E—Oil and Gas Well-Completion Operations,

Subpart F—Oil and Gas Well-Workover Operations, and Subpart Q—Decommissioning Activities to promote consistency in the regulations.

4.4.1.1.2. Oil and Gas and Sulphur Operations in the Outer Continental Shelf—Revisions to Safety and Environmental Management Systems" (SEMS II).

BSEE issued a Final Rule effective in June 2013 (78 *FR* 20423, April 5, 2013). This Final Rule (Workplace Safety Rule) includes refinements to the existing SEMS program. The SEMS II Final Rule amends the existing regulations to require operations to develop and implement additional provisions involving stop work authority and ultimate work authority, establishes requirements for reporting unsafe working conditions, and requires employee participation in the development and implementation of their SEMS programs. In addition, the Final Rule requires the use of independent third parties to perform the audits of the operators' programs.

The SEMS II Final Rule provides greater protection by supplementing operators' SEMS programs with employee training, empowering field level personnel with safety management decisions, and strengthening auditing procedures by requiring them to be environmental management systems. The SEMS is a nontraditional, performance-focused tool for integrating and managing offshore operations. The purpose of SEMS is to enhance the safety and operations by reducing the frequency and severity of accidents. The four principal SEMS objectives are:

- Focus attention on the influences that human error and poor organization have on accidents
- Continuous improvement in the offshore industry's safety and environmental records
- Encourage the use of performance-based operating practices
- Collaborate with industry in efforts that promote the public interests of offshore worker safety and environmental protection (78 *FR* 20423, April 5, 2013)

Operators had until June 4, 2014, to comply with the provisions of the SEMS II Rule, except for the auditing requirements. All SEMS audits must be in compliance with the SEMS II Rule by June 4, 2015 (78 *FR* 20423, April 5, 2013).

In addition, on April 30, 2013, BSEE and the U.S. Coast Guard (USCG) entered into a Memorandum of Agreement (MOA) entitled "Safety and Environmental Management Systems (SEMS) and Safety Management Systems (SMS)." The purpose of this MOA is to:

- Establish a process to determine areas relevant to safety and environmental management within the jurisdiction of both the USCG and BSEE where joint policy or guidance is needed
- Ensure that any future OCS safety and environmental management regulations do not place inconsistent requirements on industry
- Establish a process to develop joint policy or guidance on safety and environmental management systems (78 *FR* 20423, April 5, 2013)

4.4.1.1.3. National Notice to Lessees, Guidance to Owners and Operators of Offshore Facilities Seaward of Coast Line Concerning Regional Oil-spill-Response Plans.

Effective August 10, 2012, BSEE issued NTL No. 2012-N06 to provide clarification, guidance, and information concerning the preparing and submittal of regional Oil-spill-Response Plan (OSRP) for owners and operators of oil handling, storage, or transportation facilities, including pipelines, located seaward of the coast line (facilities) (USDOI, BSEE, 2012a).

4.4.1.1.4. National Notice to Lessees and Operators of Oil, Gas, and Sulphur Leases and Pipeline Right-of-Way Holders on Submerged Lands Seaward of the Coastline—Oil Discharge Written Follow-up Reports.

Effective November 16, 2012, BSEE issued NTL No. 2012-N07 to provide clarification about the type of information industry may provide for compliance with written follow-up report requirements in 30 CFR 254.46(b)(2) (USDOI, BSEE, 2012b).

4.4.1.1.5. National Notice to Lessees and Operators of Federal Oil and Gas Leases and Pipeline Right-of-Way Holders on Significant Change to Oil-spill-Response Plan Worst Case Discharge Scenario.

Effective August 26, 2013, BSEE issued NTL No. 2013-N02 to clarify BSEE intent regarding significant change in Oil-spill-Response Plan (OSRP) worst case discharge (WCD) scenario that requires the submittal of a revised OSRP for BSEE approval (USDOI, BSEE, 2013c).

For more information on *National Notice to Lessees and Operations of Federal Oil and Gas Leases and Pipeline Right-of-Way Holders* see http://www.bsee.gov/Regulations-and-Guidance/Notices-to-Lessees-and-Operators/.

In addition to the above reports and regulatory reforms applicable to a National perspective (including the Arctic) of the OCS, there are specific research, strategy reports, and reform initiatives for the Arctic.

4.4.1.2. Arctic Research, Strategy Reports, and Reform Initiatives

The United States is an Arctic Nation and the Arctic Region has been gaining national attention. Gradually increasing accessibility to waters previously covered by ice for a longer period of the year has increased the importance of OCS development of energy and mineral resources, maritime issues, and environmental conservation. The Arctic Region is home to a diverse ecosystem, unique environment, and an indigenous population. The Arctic Region is also viewed to hold vast energy and minerals resources.

Balancing the protection of the marine, coastal, and human environments with the need for domestic energy resources is a focus of responsible development of the energy and minerals resources of the Arctic Region. Developing energy and mineral resources in the Arctic Region presents risks of an oil spill. The Deepwater Horizon event magnified the heightened scrutiny and concerns of oil and gas development in the Arctic Region. The potential environmental effects of a low-probability, high impact event—a hypothetical VLOS in the Chukchi Sea Program – are analyzed in this Second SEIS.

The Department of the Interior has the legal responsibility to protect the marine, coastal, and human environments from serious harm of continued OCS energy exploration and development activities (43 USC §1334). This responsibility is incorporated in both BOEM and BSEE missions, and regulatory oversight.

BOEM and BSEE continue to advance strategies to mitigate drilling risk within the context of the OCSLA's mandate to foster expeditious development of the OCS while protecting the marine, coastal, and human environments. This is done by facilitating ongoing drilling safety and containment improvements through regulatory changes and new technologies. These improvements are expected to continue under the close scrutiny and evaluation of government, industry, and other concerned stakeholders. While broad statistics can be used to describe the overall likelihood of occurrence of different sizes of accidental oil discharges on the OCS, drilling risk must be assessed ultimately on a well-by-well basis because the factors that affect actual risk at a well site vary from area to area and from well to well. BOEM and BSEE are engaged in developing a better understanding of the distribution of drilling risk in the Arctic. This information will become part of the knowledge base that supports an adaptive drilling safety and oil-spill-risk-mitigation strategy.

4.4.1.2.1. BOEM's Environmental Studies Program (ESP)

The ESP develops, conducts, and oversees world-class scientific research specifically to inform decisions regarding development of OCS energy and mineral resources. The studies have led to mitigation measures to protect OCS areas and resources; increased knowledge of the marine, coastal, and human environments; and provided long-term monitoring of the effects of OCS oil and gas activity. Information on BOEM's Environmental Studies Program is addressed in Chapter 2 of this Second SEIS.

4.4.1.2.2. BSEE Research Programs

BSEE research programs focus on science and technology on the OCS to protect both energy and natural resources. BSEE Research Programs continually seek greater knowledge in the following primary areas:

- Oil-spill-Response Research to improve the methods and technologies used for oil-spill detection, containment, treatment, recovery, and cleanup.
- Technology Assessment Program supports research associated with operational safety and pollution prevention. This program is primarily concerned with assessing offshore engineering technology for use in advancing clear agency regulatory objectives.
- Ohmsett National Response Test Facility is the premier training site for oil-spill-response personnel. Government agencies including the U.S. Coast Guard and the Navy – as well as private industry and oil-spill-response organizations – train their emergency response personnel with real oil and their own full-scale equipment. Some of the testing activities have included remote sensing tests, wave energy conversion device tests, skimmer and boom tests, dispersant tests, alternative fuel recovery tests, and industry oil-spill-response-training classes. BSEE contracts with companies to manage the Leonardo, New Jersey facility, which is located at Naval Weapons Station Earle, Waterfront. The research and training facility centers around a 2.6 million-gallon salt water tank (see: http://www.bsee.gov/Research-and-Training/index/).

BSEE is the principal Federal agency funding offshore oil-spill-response research, and Ohmsett is a key part of the bureau's Oil-spill-Response Research Program. Many of today's commercially available oil-spill-cleanup products have been tested at Ohmsett and a considerable body of performance data and information on mechanical response equipment has been obtained there. This information is used by response planners in reviewing and approving facility response and contingency plans.

4.4.1.2.3. Interagency Working Group on Coordination of Domestic Energy Development and Permitting in Alaska

On July 12, 2011, President Obama signed Executive Order 13580 to establish the Interagency Work Group on Coordination of Domestic Energy Development and Permitting in Alaska. The focus of this group is to increase interagency coordination regarding the safe and responsible development of onshore and offshore energy resources and all associated infrastructure in Alaska while protecting human health and the environment, as well as indigenous populations.

A few of the working group's primary functions include facilitating orderly and efficient decision-making regarding the issuance of permits and the conduct of environmental reviews; ensuring information sharing and integrity of scientific and environmental information and cultural and traditional knowledge; engaging in long-term planning and ensuring coordination regarding oil-spill prevention, preparedness, and response; coordinating Federal engagement with State, localities, and tribal governments; and collaborating on stakeholder outreach.

The interagency working group is chaired by Deputy Secretary of the Department of the Interior and includes deputy level representatives or officials at the equivalent level from: Department of Defense; Department of Commerce; Department of Agriculture; Department of Energy; Department of Homeland Security; Environmental Protection Agency; and Office of the Federal Coordinator for the Alaska Natural Gas Transportation Projects. Working closely with the Chair, is the Domestic Policy Council. The Council includes representatives from the Council on Environmental Quality; Office of Science and Technology Policy; Office of Management and Budget; and the National Security Staff (see http://www.whitehouse.gov/the-press-office/2011/07/12/executive-order-13581-interagency-working-group-coordination-domestic-en).

4.4.1.2.4. Arctic Environmental Response Management Application

In February 2012, BSEE and NOAA announced their partnership to enhance the Environmental Response Management Application (ERMA) for the Arctic region by summer 2012. ERMA is a Web-based interactive geographic information system (GIS) tool designed to assist emergency responders and environmental resource managers in addressing incidents that may adversely affect the environment. ERMA integrates and synthesizes real-time and static data into a single interactive map to support response evaluation and decisions, as well as improves communication and coordination among responders and environmental stakeholders. ERMA was invaluable in assisting with response operations during Deepwater Horizon event and is currently supporting National Resource Damage Assessment determinations. The NOAA, Office of Response and Restoration has the Arctic ERMA available for viewing at http://response.restoration.noaa.gov/maps-and-spatial-data/environmental-response-management-application-erma/arctic-erma.html. Arctic ERMA is also a pilot project supporting the efforts of the Arctic Council's Emergency Prevention, Preparedness, and Response Working Group. Arctic ERMA is a partnership among NOAA's Office of Response and Restoration, NOAA's Office of Ocean and Coastal Resource Management, BSEE, the Oil-spill-Recovery Institute, and the University of New Hampshire's Coastal Response Research Center.

4.4.1.2.5. U.S. Arctic Research Plan FY 2013-2017

In February 2013, the Executive Office of the President, National Science and Technology Council released the Arctic Research Plan for FY 2013-2017. The Arctic Research Plan was produced by the Interagency Arctic Research Policy Committee (IARPC) in recognition of responsibilities described in the Arctic Research Policy Act of 1984. IARPC activities are chaired by the National Science Foundation and serve to coordinate science and technology policy across diverse Federal institutions.

IARPC, which consists of representatives from 14 Federal agencies, departments, and offices, has identified seven research areas that will inform national policy and benefit significantly from close interagency coordination (NSTC, 2013). These research areas are:

- Sea ice and marine ecosystems
- Terrestrial ice and ecosystems
- Atmospheric studies of surface heat, energy, and mass balances
- Observing systems
- Regional climate models
- Adaptation tools for sustaining communities
- Human health

Much of BOEM's directed research supports the Arctic Research Plan FY 2013-2017. More information about how BOEM studies intersect with the U.S. Arctic Research Plan is on the BOEM website at: http://www.boem.gov/akstudies/ (USDOI, BOEM, 2014a).

4.4.1.2.6. Managing for the Future in a Rapidly Changing Arctic

In March 2013, the Interagency Working Group on Coordination of Domestic Energy Development and Permitting in Alaska issued a report: Managing for the Future in a Rapidly Changing Arctic, A Report to the President (Clement, Bengtson, and Kelly, 2013).This report advocated for "holistic, integrated approach to management" in the Arctic. The following principles were stated:

- Whole-of-government coordination to improve efficiency and operational certainty
- Direct and meaningful partnership with stakeholders
- Science-based decision-making focused on ensuring sustainable ecosystems
- Adaptive approaches guided by ongoing research and monitoring
- A region-wide planning approach that looks across jurisdictional boundaries
- Improved understanding and consideration of cumulative impacts of human activities in the Arctic

A key goal of oil and gas development must be to "ensure that offshore operations are accomplished safely. Sufficient personnel and logistical resources should be made available by the commercial entities extracting these resources to ensure oil and gas resources are developed safely and in an environmentally responsible manner. The United States should be a leader in developing Arctic offshore regulations and standards."

The report emphasized that decisions should be science-based and focused on ensuring sustainable ecosystems and continuity of ecosystems functions and services by:

- Identifying and protecting areas of significant ecological or cultural importance and/or sensitivity, along with the variables that define them
- Using the best available science to understand ecological processes, to identify and measure indicators of change, and to make policy and management decisions
- Utilizing and integrating traditional knowledge into decision-making
- Investing in research that meets the needs of managers and stakeholders, and coordinating data collection and analysis across the U.S. Arctic
- Using precaution in decision-making, especially where the health, productivity, and resilience of ecosystems may be compromised

The report does not recommend new regulations or represent new policy decisions, but it does call for a review of the activities of over 20 Federal agencies involved in the U.S. Arctic with an eye toward increased coordination and the elimination of duplication of efforts. Congress has entrusted the Federal government with primary jurisdiction over nearly three quarters of the U.S. Arctic's land mass. In addition, the Federal government has a special relationship with Alaska Natives, including Alaska Native tribes and native corporations.

4.4.1.2.7. Review of Shell's 2012 Alaska Offshore Oil and Gas Exploration Program: Report to the Secretary of the Interior

In March 2013, the Secretary of the Interior announced the findings of a Departmental Review detailing Shell's Offshore Oil and Gas Exploration Program in 2012 (USDOI, 2013a). The company experienced major problems with its overall exploration program. This report assessed, at a high level, Shell's performance across all aspects of its 2012 Alaska offshore exploration program, and identified key lessons to be learned from Shell's experience.

This review identified seven key principles and prerequisites for safe and responsible offshore exploration drilling the Arctic OCS—five applying to industry and two relevant to government oversight.

Five principles applying to industry:

- All phases of an offshore Arctic program – including preparations, drilling, maritime and emergency response operations – must be integrated and subject to strong operator management and government oversight.
- Arctic offshore operations must be well-planned, fully ready and have clear objectives in advance of the drilling season.
- Operators must maintain strong, direct management and oversight of their contractors.
- Operators must understand and plan for the variability and challenges of Alaskan conditions.
- Respect for and coordination with local communities.

Two principles applying to government oversight:

- Continued strong coordination across government agencies is essential. The government was strong in the level of interagency coordination, information-sharing, and cooperation related to regulatory approval process and oversight of Shell's 2012 program. The report viewed government oversight and public engagement as successes to be carried forward and improved upon in the future.
- Industry and government must develop an Arctic-specific model for offshore oil and gas exploration in Alaska. Logistical and geographical challenges are great in the Arctic; limited infrastructure makes it difficult to bring equipment and resources into the area, and mounting response operations is limited by changing weather and ice conditions at the end of the season. The report recommended that Government and industry should continue to evaluate the potential development of Arctic-standards in the areas of drilling and maritime safety and emergency response equipment systems.

4.4.1.2.8. National Strategy for the Arctic Region

In May 2013, President Obama released the National Strategy for the Arctic Region (White House, 2013). The strategy articulates the U.S. strategic priorities to effectively integrate the Federal departments and agencies with activities already underway in the State of Alaska and at an international level. This strategy is intended to position the United States to respond effectively to challenges and emerging opportunities arising from significant increases in Arctic activity due to the diminishment of sea ice and the emergence of a new Arctic environment. The strategy is built on three lines of effort that include the following aspects:

- Advance United States Security Interests
- Evolve Arctic Infrastructure and Strategic Capabilities
- Enhance Arctic Domain Awareness
- Preserve Arctic Region Freedom of the Seas
- Provide for Future United States Energy Security
- Pursue Responsible Arctic Region Stewardship
- Protect the Arctic Environment and Conserve Arctic Natural Resources
- Use Integrated Arctic Management to Balance Economic Development, Environmental Protection, and Cultural Values
- Increase Understanding of the Arctic through Scientific Research and Traditional Knowledge

- Chart the Arctic region
- Strengthen International Cooperation
- Pursue Arrangements that Promote Shared Arctic State Prosperity, Protect the Arctic Environment, and Enhance Security
- Work through the Arctic Council to Advance U.S. Interests in the Arctic Region
- Accede to the Law of the Sea Convention
- Cooperate with other Interested Parties
- Inform the strategy by a number of guiding principles
- Safeguard Peace and Stability
- Make Decisions Using Best Available Information
- Pursue Innovative Arrangements
- Consult and Coordinate with Alaska Natives

The three lines of effort, as well as the guiding principles are meant to be acted upon as a coherent whole.

4.4.1.2.9. Implementation Plan for the National Strategy for the Arctic Region

In January 2014, the Whitehouse released the implementation plan for the National Strategy for the Arctic Region (White House, 2014a). This Implementation Plan follows the structure and objectives of the Strategy's three lines of effort and is consistent with the guiding principles. The implementation plan recognized that climate change was already affecting the entire global population and Alaska residents were experiencing the impacts in the Arctic. The implementation plan directs activities to be aligned with Executive Order 13653 *Preparing the United States for the Impacts of Climate Change.* The implementation plan provides the objective for each Federal activity, lists the next steps and time period to accomplish the objective, specifies the way to measure progress, and designates the lead Cabinet entity and supporting Cabinet entities to accomplish the objective.

One of the key components of the implementation plan is to use "Integrated Arctic Management to Balance Economic Development, Environmental Protection, and Cultural Values." This component recognized and was influenced by the report: Managing for the Future in a Rapidly Changing Arctic (Clement, Bengtson, and Kelly, 2013) sponsored by the Interagency Working Group on Coordination of Domestic Energy Development and Permitting in Alaska, discussed above. This Second SEIS is written in the spirit of implementing Integrated Arctic Management. One of the recommendations in the report (Clement, Bengtson, and Kelly, 2013) was to coordinate and streamline Federal actions--linking science and management and environmental evaluations.

The *Arctic Research Plan* directly supports *the Implementation Plan for the National Strategy for the Arctic Region.*

On February 14, 2014, Secretary Kerry announced the U.S. Department of State (USDOS) would establish a Special Representative for the Arctic Region. Retired Admiral Robert Papp was appointed to serve as U.S. Special Representative for the Arctic, to show that the United States was committed to "elevating attention and effort to keep up with opportunities and consequences presented by the Arctic's rapid transformation—a very rare convergence of almost every national priority in the most rapidly-changing region on the face of the earth" (USDOS, 2014).

4.4.1.2.10. National Research Council of the National Academies Report: Responding to Oil Spills in the U.S. Arctic Marine Environment

In April 2014, the National Research Council released the report Responding to Oil Spills in the U.S. Arctic Marine Environment to assess the state of science regarding oil-spill response and environmental assessment in the Arctic region. The study was sponsored by the U.S. Arctic Research Commission, American Petroleum Institute, U.S. Coast Guard, U.S. Department of the Interior, Bureau of Ocean Energy Management, Bureau of Safety and Environmental Enforcement, Marine Mammal Commission, National Oceanic and Atmospheric Administration, Oil-spill-Recovery Institute, and the National Academy of Sciences. The National Academy of Sciences, National Academy of Engineering, Institute of Medicine, and National Research Council make up the National Academies (see http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=18625). The report made recommendations on topics regarding long-term community based Arctic observing system; oil-spill response research; use of dispersants; coordination of operations and logistics for an Arctic oil spill; and strategies for response and mitigation (NRC, 2014).

4.4.1.3. Upcoming Regulatory Reform for the Arctic

As a result of Departmental Review detailing Shell's Offshore Oil and Gas Exploration Program in 2012 (USDOI, 2013a), BOEM and BSEE are developing proposed Arctic OCS regulations governing exploration drilling for oil and gas in the Chukchi and Beaufort Seas. The Arctic OCS proposed regulations are intended to codify and further develop the Arctic-specific standards established for Shell's 2012 exploration program, and are intended to strengthen safety and environmental protection for Arctic OCS exploratory operations. Government and industry should continue to evaluate the potential development of additional Arctic-specific standards in the areas of drilling and maritime safety and emergency response equipment and systems. The United States has a leading role among Arctic nations in establishing appropriately high standards for safety, environmental protection and emergency response governing offshore oil and gas exploration in the Arctic Ocean. It is incumbent, therefore, on the United States to lead the way in establishing an operating model and standards tailored specifically to the extreme, unpredictable and rapidly changing conditions that exist in the Arctic even during the open-water season (USDOI, 2013a).

The new regulations will stress the need for comprehensive and integrated planning for oil and gas exploration activities, from mobilization to exploratory drilling to demobilization. The release of the proposed rule will include an opportunity for public comment to continue the important dialogue on drilling operations in the Arctic (USDOI, BSEE, 2014).

Further, BSEE has been focused on source control and containment in the Arctic. By ensuring these systems are in place prior to drilling, BSEE's intention is to prevent or minimize oil releases in the event of an emergency situation. This is a shift from how DOI has approached offshore oil and gas development in the past. This approach, however, is consistent with the lessons learned from the Deepwater Horizon tragedy. Additionally, this approach is a key component of risk management as it promotes preparing for emergency situations before the emergency occurs. Such a proactive approach is also consistent with the harsh and isolated conditions that operators are likely to face in the Arctic region (USDOI, BSEE, 2014).

Most importantly, DOI's goal is to ensure that operators have taken the necessary steps to ensure that drilling operations performed in the Arctic are done safely. This includes proper internal controls and planning, two areas that were highlighted in both the Department of the Interior's and U.S. Coast Guard's reports on Shell's operations in Alaska (USDOI, BSEE, 2014).

In addition, BSEE has been working with international Arctic offshore regulators, because an incident in one nation's waters can quickly affect other nations. This dialogue provides a valuable opportunity to benchmark against best practices in other countries, relating to prevention, preparedness, and response. BSEE is also the lead for many Arctic initiatives contained in the U.S. National Ocean Policy. Overall, BSEE is participating in joint training and exercises, supporting development of international response guidelines, identifying response infrastructure gaps and ways to mitigate them, and conducting field experiments to test technology capabilities. All of this is designed to understand how to allow Arctic drilling activity to be conducted more safely (USDOI, BSEE, 2014).

4.4.1.3.1. International - Arctic Council—an Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic

In May 2013, the Governments of Canada, Kingdom of Denmark, Republic of Finland, Iceland, Kingdom of Norway, Russian Federation, Kingdom of Sweden, and the United States entered into an agreement to strengthen cooperation, coordination and mutual assistance on oil pollution preparedness and response in the Arctic to protect the marine environment from pollution by oil (see: http://www.arctic-council.org/eppr/agreement-on-cooperation-on-marine-oil-pollution-preparedness-and-response-in-the-arctic/)(Arctic Council, 2013b).

4.4.1.3.2. International – Arctic Council – Report: Arctic Offshore Oil and Gas Guidelines: Systems Safety Management and Safety Culture

In May 2014, the Working Group-Protection of the Arctic Marine Environment (PAME) presented the report on Arctic Offshore Oil and Gas Guidelines: Systems Safety Management and Safety Culture at the meeting of Senior Arctic Officials in Yellowknife, Canada. The PAME report is "primarily aimed at providing guidance to Arctic states on available options to promote improved safety culture and robust safety management systems in the Arctic offshore oil and gas industry. It tries to establish a common understanding of the goals and processes for managing major risk elements, and it outlines targeted actions or approaches which can act to guide Arctic national and regional authorities in regulating or influencing critical human and organizational safety systems." (Arctic Council, 2014).

4.4.1.4. OCS Well Control Incidents

The risk of an unlikely or rare event, such as a loss of well control incident, is determined using the best available historical data. The Five-Year Program Final PEIS (USDOI, BOEM, 2012) provides a detailed discussion of the OCS well control incidents and risk factors that could contribute to a long duration loss of well control. Risk factors include geologic formation and hazards; water depth and hazards, geographic location (including water depth); well design and integrity; loss of well control prevention and intervention; scale and expansion; human error; containment capability; response capability; oil types and weathering/fate; and specific regional geographic considerations, including oceanography and meteorology.

The historical data indicates that loss of well control events resulting in oil spills are infrequent occurrences, and those resulting in large accidental oil spills are even rarer events (Anderson and Labelle, 2000; Anderson, Mayes, and LaBelle, 2012; Bercha Group, Inc., 2006; Bercha Group, Inc., 2008a,b; Bercha Group, Inc. 2011; Bercha Group, Inc. 2014a; Izon, Danenberger, and Mayes, 2007; Ji, Johnson, and Wikel, 2014; Robertson et al., 2013; USDOI, BOEMRE 2011c; USDOI, BOEM, 2012). This conclusion is also supported by the Norwegian SINTEF Offshore Blowout Database, which tracks worldwide offshore oil and gas blowouts where risk-comparable drilling operations are analyzed (OGP, 2010; DNV, 2010b; DNV, 2011). Blowout frequency analyses of the SINTEF database suggest the highest risk operations are associated with exploration drilling in high-pressure, high-temperature conditions (DNV, 2010b; DNV, 2011) that are not expected to occur in the Leased Area. Further, new drilling regulations and recent advances in containment technology may reduce the frequency and size of oil spills from OCS operations (DNV, 2010b; DNV, 2011). However, as the 2010 *Deepwater Horizon* event (DWH event) illustrated, a VLOS can occur and result in substantial impacts.

Quantifying the frequency of VLOSs from a loss of well control event is challenging as relatively few large oil spills that can serve as benchmarks have occurred on the OCS (Scarlett et al. 2011). Prior to the DWH event, the three largest blowout spills on the OCS were 80,000 bbl, 65,000 bbl, and 53,000 bbl in volume. All of these spills occurred before 1971. Since 1971, substantial new regulatory requirements have been implemented to improve safety and reduce the likelihood of such spills occurring (Visser, 2011). From 1971–2010, with the additional regulatory requirements in place, fewer than 50 well control incidents occurred on the OCS from more than 41,800 wells drilled and almost 16 Bbbl of oil produced (USDOI, BOEM, 2012). Collectively, these 50 incidents comprised a total of 2,000 bbl of crude or condensate oil spilled, with the largest individual spill—other than the DWH event—being 450 bbl. The DWH event was the only VLOS to occur between 1971 and 2010 (USDOI, BOEM, 2012).

Based on an analysis of this historic data from both the 1971-2010 (the modern regulatory era) and the 1964-1971 time frames, the frequency of a loss of well control occurring and resulting in a VLOS of different volumes was determined (USDOI, BOEM, 2012, Figure 4.4.3-1). This analysis, which is set forth in the Five-Year Program Final PEIS, was used to calculate the frequency (per well) of a spill exceeding 2.2 Mbbl, which is the VLOS volume assumed for the purpose of analysis in this Second SEIS. This frequency was determined to be $>10^{-4} – <10^{-5}$ (USDOI, BOEM, 2012, Table 4.3.3).

4.4.2. 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 BOEM using similar assumptions and identical analytical methods. However, these calculations differ in several important ways (Table 4-53):

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 4.4.1. It is recognized that the frequency for a VLOS on the OCS from a well control incident is very low. Recent analyses have estimated the frequency ranges from $>10^{-4} – <10^{-5}$ (USDOI, BOEM, 2012, Table 4.3.3; Bercha Group, Inc., 2014a).

Table 4-53. Comparison between VLOS and 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 (EP) or Development and Production Plan (DPP).
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 regulations 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 chance that the exploration well would 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.

4.4.2.1. VLOS Parameters

4.4.2.1.1. Rate, Time and Composition of Hypothetical Spill

The VLOS scenario assumes a blowout leading to a very large oil spill. In developing this scenario, BOEM first generated a hypothetical oil discharge model that estimates the highest possible uncontrolled flow rate that could occur from any known prospect in the Leased 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 4-55 summarizes the results of the discharge model for the hypothetical well. The oil discharge climbs rapidly to over 61,000 bbl/day during Day 1. After peaking in Day 1, Figure 4-17 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 4-55).

The decline in the flow rate flattens somewhat after Day 40, falling to 20,479 bbl/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 bbl.

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 (15.6°C) 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 4-55) is also 930 cf/bbl. As shown in Table 4-55, 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 depressurized 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 4-55) 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.

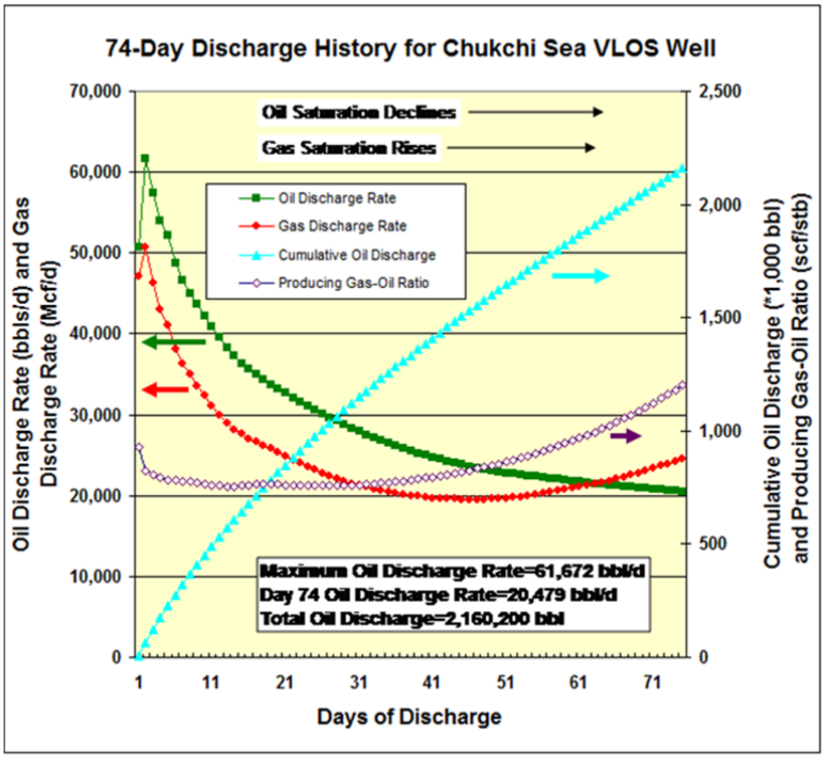


Figure 4-17. Changing 74 Day Discharge Rate after Well Blowout. *Decline in daily discharge rates and rising cumulative oil discharge for a 74-day period after a blowout at a hypothetical exploration well in the central Chukchi Sea Planning Area.*

4.4.2.1.2. 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 may sink. If the blowout occurs in shallow water, the sinking rig may land in the immediate vicinity; if the blowout occurs in deeper water, the rig 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 Leased 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 Leased 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 blowout preventor). 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 environmental effects analysis in Section 4.5 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 4.4.2.2.

4.4.2.1.3. 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 the Leased Area would be anticipated to occur within 10 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.

4.4.2.1.4. 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 4-55 summarizes the results of the discharge model for the hypothetical VLOS. The oil discharge climbs rapidly to over 61,000 bbl/day during day one. After peaking in Day 1, Figure 4-17 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 4-55). The decline in the flow rate flattens somewhat after Day 40. As shown in Table 4-55, the cumulative oil discharge over a 74-day spill is 2,160,200 bbl.

To simplify the analysis, BOEM estimates 2.2 MMbbl of oil are spilled in the VLOS scenario.

4.4.2.1.5. 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 analyzed in Section 4.4.2.3, 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 2015-N01, 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 (USDOI, BOEM, 2015). For purposes of analysis within this VLOS scenario, BOEM estimates 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 4-54, below.

Table 4-54. Time Required to Drill Relief Well and Kill Discharge following VLOS at a Well.

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 Chukchi Sea to Drill 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 enroute—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**

Notes: Estimated time periods required to drill a relief well and to kill the discharge at the Chukchi Sea VLOS Well (provided by BSEE AKOCSR Field Operations).

*estimates based upon previous operations in the area.

4.4.2.2. Spill Cause, Movement, and Response 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 MMbbl (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 4-55. AVALON/MERLIN Discharge Model Results for a Chukchi Sea Well VLOS.

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 (Mbbl)	Cumulative Gas Discharge (MMcf)	Cumulative Water Discharge (bbl)	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

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 (Mbbl)	Cumulative Gas Discharge (MMcf)	Cumulative Water Discharge (bbl)	Near-Wellbore Reservoir Pressure (psi)
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

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 (Mbbl)	Cumulative Gas Discharge (MMcf)	Cumulative Water Discharge (bbl)	Near-Wellbore Reservoir Pressure (psi)
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

Notes: 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; Mbbl = 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.

Table refers to a very low probability hypothetical VLOS, occurring over a maximum (74-day) time period. The model estimates discharges during mobilization, drilling, and completion of a relief well.

4.4.2.2.1. 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 (Appendix A, Table A.1-27). 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 A, Section A-7.5 and Tables A.2-28, 30, 34, 36, 40, 42, 54, 60 and 66).

4.4.2.2.2. 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 (NRC, 2003b). 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 (NRC, 2003b). Once oil enters the environment, it begins to change through physical, chemical, and biological weathering processes (NRC, 2003b). 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 (NRC, 2003b; 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 (2007 FEIS, Appendix A, Figure A.1-1 Fate of Oils Spills in the Ocean During Arctic Summer, and Figure A-2. Fate of Oil Spills in the Ocean During Arctic Winter). 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 4-56. On average, light-weight crude oils are characterized as outlined in Table 4-56.

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 4-56. Properties and Persistence for Light Weight Crude Oil.

Light-weight Crude Oil – Properties and Persistence	
Hydrocarbon compounds	Up to 10 carbon atoms
API °	>31.1°
Evaporation rate	Rapid (within 1-3 days) and complete in summer; Slower (1-30 days) in winter to complete
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).

4.4.2.2.3. 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 (15.6°C) 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 4-55) is also 930 cf/bbl. As shown in Table 4-55, 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 drilling equipment) estimated for completion of a relief well (very large discharge case) is 1,808 MMcf. For purposes of analysis BOEM estimates 1.8 Bcf (billion cubic feet). Natural gas is primarily made up of methane (CH_4) and ethane (C_2H_6) which make up 85-90% of the volume of the mixture.

4.4.2.2.4. 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 3 days to 360 days based on BOEM oil-spill trajectory analysis (Appendix A). 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 (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 dissipate over time due to mixing and advection (Boehm and Fiest, 1982).

4.4.2.2.5. 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" (Federal Interagency Solutions Group, 2010). For planning purposes, USCG estimates that 5–30 percent of oil would reach shore in the event of an offshore spill (33 CFR Part 154, Appendix C, Table 2).

4.4.2.2.6. 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. The length of oiled shoreline increases over time as the spill continues. Dependent upon winds and currents throughout the VLOS event, already impacted areas could have oil refloated and oil other areas, increasing the oiled area.

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.

4.4.2.2.7. 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 and 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.

4.4.2.2.8. 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. 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 analyzed in greater detail below in “Effect of Ice on Response Actions.” For a comprehensive list of Arctic oil-spill response research projects that BSEE has funded, the reader is referred to BSEE Arctic Oil-spill Response research (USDOI, BSEE, 2014b).

In the event of a VLOS, two governmental organizations would assume prominent roles in coordinating response efforts: the Federal On-Scene Coordinator (FOSC), and 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. Although recent research in the use and effectiveness of chemical dispersants has shown varied results, use of dispersants may still be a response option for the Chukchi Sea. Some research has shown that dispersants can be effective in cold and ice infested waters under certain conditions (S.L. Ross Environmental Research, 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. A recent study funded by BSEE concluded that application of dispersants in the Chukchi Sea would be virtually impossible under winter conditions and that even in summer, aerial application would be impossible half the time and vessel application about 20 percent of the time (Nuka, 2014).There are dispersant stockpiles located in 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 Unified Plan for 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 EPA, DOI, and DOC. The decision regarding how and when dispersants would be applied would also reside with the FOSC in consultation with EPA, DOI, and DOC. 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 Department of Environmental Conservation’s 2008 In-situ Burning 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 responders’ 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 BOEM spill response experts.

- Between 5 and 10 staging areas would be established.
- About 15 to 20 vessels (i.e. the Nanuq, Endeavor Barge, Tor Viking, other barges from Prudhoe Bay, vessels from Cook Inlet and Prince William Sound, and other vessels of opportunity) could be used in offshore areas. Some of these would be capable of oil skimming. 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 (Federal Interagency Solutions Group, 2010) 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 (USFWS, 2010b).

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 nor considered during OSRA modeling.

4.4.2.3. Scenario Phases and Impact Producing Factors

This section specifically identifies the manners in which the hypothetical VLOS event described above could impact the environment. The intent of this section is to facilitate thorough yet focused impacts analysis in Section 4.5.

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 impacts to the environment. These components are termed “Impact Producing Factors,” or IPFs, and will be used in Section 4.5 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 4.5.

4.4.2.3.1. 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.

4.4.2.3.2. 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.

4.4.2.3.3. 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.

4.4.2.3.4. 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.

4.4.2.3.5. 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.

4.4.2.3.6. 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 4-54). 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 Revised OCS Lease Exploration Plan, Chukchi Sea (Shell, 2012). The Chukchi Sea Regional Exploration Oil Discharge Prevention and Contingency Plan (cPlan) (Shell, 2011b) utilizes:

- 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 analyzed 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 BOEM 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 (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. Five 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 (and 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 (and the rig is destroyed and sinks at the location). Opportunities for operational intervention and response vary in each of these circumstances (Table 4-57) and are, ultimately, important in determining the potential effects of the spill.

Table 4-57. Blowout Scenarios, 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.

Location of Blowout and Leak	Key Differences in Impacts, Response, and/or Intervention
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.

4.5. 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 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 (LAs) to reach a given resource. The model and its components are further explained below and discussed in detail in Appendix A. 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 the Leased Area.

The reader may notice that this VLOS effects analysis is organized slightly differently than the 2007 FEIS environmental effects analysis and the portion of this Second 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.

The purpose of this section is 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 BOEM approval of an Exploration Plan (EP) and an Application for Permit to Drill (APD, submitted to BSEE)
- 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

4.5.1. OSRA Model (Oil-spill Trajectories)

BOEM uses an OSRA (Oil-spill Risk Analysis) model to simulate estimated oil-spill trajectories; the OSRA model is a method for estimating where a VLOS may go. It is an exercise in probability. For this analysis, BOEM presumes an oil spill occurs and the model estimates the percentage of oil-spill trajectories that could contact 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 15-77 years into the future. For purposes of analysis, BOEM 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 VLOS have been addressed in Section 4.4.2.

There are some differences between this analysis and BOEM's earlier analysis of a large oil spill(s) in Section 4.1.2.5. This Second SEIS evaluated a large oil spill (≥1,000 bbl) using the conditional probabilities of contact assuming a large oil spill occurred. The analysis used 6 launch areas (LAs) within the leased area representing the places where a spill could originate from an exploration or development activity. The analysis also used 124 ERAs, 132 land segments (LSs), 40 boundary segments (BSs) and 46 grouped land segments (GLS) representing biological, economic or social resources (see Appendix A: Maps A.1-A-4 and Tables A.1-10-A.1-17). BOEM uses the 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 Leased 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 VLOS. The Arctic OSRA calculations are run for as long as 360 days and were appropriate for a VLOS 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 4.4.2 suggests that a VLOS 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 BOEM 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, 2003; Ramseur, 2010). For the longer period BOEM 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. BOEM analyzes oil-spill trajectories for 60 and 360 days during summer. A VLOS 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. BOEM analyzes 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 A (Tables A.2-28, 30, 34, 36, 40, 42, 54, 60 or 66).

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 BOEM 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.

Within the Leased Area, launch areas (LAs) 1, 4, 5, 6, 10 or 11are the areas where a VLOS could originate from a well control incident (Appendix A, Map A-5). 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 1, 4, 5, and 6have a stochastic easterly direction influenced as well by a southwestward component.
- LA 10 has the most stochastic southwest northeast influence. LAs 5, 10 and 11, are influenced from the Beaufort Gyre.

A VLOS trajectory analysis was evaluated for all resources except economy, air quality, sociocultural, and public health. Specific ERAs 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.

4.5.2. 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.

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 USEPA administers and enforces the CWA 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 CWA, Section 403 and no waterbodies are identified as impaired (CWA, Section 303) within the Arctic region by the State of Alaska (ADEC, 2011b).

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 CWA 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* release (Gulf of Mexico, 1979–1980 at approximately 50 m (164) water depth), liquid hydrocarbons in the spill plume measured >10 ppm within 8 km of the release, to 0.02 ppm at 24 km (15 mi) from the release, and to <0.005 ppm at 40 km (25 mi) from the release (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 (NRC, 1985).

At the *Ekofisk Bravo* release 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 (12 mi) of the site when measured, starting 1.5 days into the 7.5 day release (Grahl-Nielsen, 1978). Lesser amounts of oil (<0.02 ppm) were detectable in some samples, at 56 km (35 mi) from the site, but not at 89-km (55 mi). 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 (9.8 ft), and the most oil and highest concentrations were in the top 1 m (Mackay and Wells, 1983).

Camilli et al. (2010) conducted a subsurface hydrocarbon study two months after the *Deepwater Horizon* (DWH) seafloor release (depth 1,500 m or 4,921 ft) in the Gulf of Mexico. They found a continuous oil plume at a depth of approximately 1,100 m (3,609 ft) that extended for 35 km (21.7 mi) from the release 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 (328 ft). Polycyclic aromatic hydrocarbons (PAH) 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 (3,280-4,593 ft) extending as far as 13 km (8 mi) from the subsurface release 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 (3,280-4,265 ft). These concentrations exceeded the background concentration of hydrocarbon gasses by up to 75,000 times. Results from a study by Yvon-Lewis, Hu, and Kessler (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 release 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 release remained dissolved in the deep ocean waters. Valentine et al. (2010) reported that two months after the DWH release, 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 release 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 release. The fate of 771,000 gallons of chemical dispersants injected at the DWH wellhead near the seafloor (1,500 m or 4,921 ft) 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 (3,281-3,937 ft) depth 64 days after dispersant application was stopped and as far away as 300 km (186 mi). They concluded that the chemical dispersants at this depth underwent slow rates of biodegradation.

In addition to the studies discussed above, Table 4-58 presents a summary of other recent journal articles published on the effects of the Deepwater Horizon oil spill on water quality. The articles discuss the distribution, extent, concentration, and composition of the Deepwater Horizon oil over time (Sammarco et al., 2013; Spier et al., 2013; Reddy et al., 2013; Ryerson et al., 2012; Wade et al., 2011; and Adcroft et al., 2010). Contaminant concentrations in the water and in the seafloor sediments were studied by Nowell et al., (2011). The concentrations of polycyclic aromatic hydrocarbons (PAH) that were bioavailable were investigated by Allan, Smith, and Anderson (2012). Passow et al. (2012) looked at microbial processes involved in the formation of marine snow (particles >0.5 mm comprised of many smaller, organic and inorganic particles) in the presence of the Deepwater Horizon oil.

Table 4-58. Recent Journal Articles on the Effects of the DWH Oil Spill on Water Quality.

Title of Article	Date	Authors
Distribution and concentrations of petroleum hydrocarbons associated with the BP/Deepwater Horizon Oil Spill, Gulf of Mexico	2013	Sammarco, Kolian, Warby et al.
Distribution of hydrocarbons released during the 2010 MC252 oil spill in deep offshore waters	2013	Spier, Stringfellow, Hazen et al.
Composition and fate of gas and oil released to the water column during the Deepwater Horizon oil spill.	2012	Reddy, Arey, Seewald et al.
Impact of the Deepwater Horizon Oil Spill on bioavailable polycyclic aromatic hydrocarbons in Gulf of Mexico coastal waters	2012	Allan, Smith, and Anderson
Marine snow and associated microbial processes as drivers for oil transformation in surface Gulf of Mexico waters.	2012	Passow, Ziervogel, Asper, Diercks
Chemical data quantify Deepwater Horizon hydrocarbon flow rate and environmental distribution.	2012	Ryerson, Camilli, Kessler et al.
Analyses of water samples from the Deepwater Horizon Oil-spill: documentation of the subsurface plume	2011	Wade, Sweet, Sericano et al.
Organic contaminants, trace and major elements, and nutrients in water and sediment sampled in response to the Deepwater Horizon oil spill	2011	Nowell , Ludtke, Mueller et al.
Simulations of underwater plumes of dissolved oil in the Gulf of Mexico	2010	Adcroft, Hallberg, Dunne et al.

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 release occurred in at a depth of 1,500 m (4,921 ft); potential Chukchi Sea drilling would be at <50 m (164 ft). 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, Larsson, and Sehlstedt, 1991; Rye, Brandvik, and Strøm, 1997).

Meanwhile, water temperatures in the shallow Chukchi Sea are similar to the deepwater temperatures in the Gulf of Mexico, suggesting the Chukchi Sea 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, Gannon, 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 release and a hypothetical release in the Chukchi Sea problematic.

The following subsections describe the types of effects that could occur during each Phase of the VLOS scenario.

4.5.2.1. Phase 1 (Initial Event)

The initial release 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 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).

4.5.2.2. 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 (NRC, 2003a).

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; Payne et al., 1984) 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 (33 ft) in the water column, it becomes diluted and may spread horizontally over about 10,000 m (6.2 mi). 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 km, 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 km.

4.5.2.3. 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.

4.5.2.4. Phase 4 (Spill Response and Cleanup)

4.5.2.4.1. 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, Pinza, and Gardiner, 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 (NRC, 2005b). Recent papers also show that some dispersants can inhibit or leave unaffected biodegradation of oil in the water column, while others noted accelerated biodegradation (Fingas, 2014).

4.5.2.4.2. 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" (NOAA, 2011). 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.

4.5.2.4.3. 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, icebreakers 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.

4.5.2.4.4. Drilling of Relief Well

Drilling an emergency relief well would entail discharge of drilling muds and cuttings. These discharges would be regulated by the USEPA under an NPDES permit. In 2012, a general NPDES Permit (AKG-28-8100) became effective for "Oil and Gas Exploration Facilities on the Outer Continental Shelf in the Chukchi Sea."

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. There is potential for accidental spills and potential for introduction of invasive species from vessel traffic while drilling a relief well.

4.5.2.4.5. 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.

4.5.2.5. 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 would continue from oil leaching from sediments and oil resuspended, including resuspension of polycyclic aromatic hydrocarbons (PAHs). Dispersant residue on the seafloor could also leach into the water. Sunlight (UV radiation) increases the toxicity of leached PAHs, so summer sunlight in Arctic Alaska could exacerbate the amount and degree of toxicity.

4.5.2.6. 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 A, Table A.1-27). It is estimated that within 30 days in a summer spill, 33% of the oil spill would disperse and 37% would evaporate (Appendix A, Table A.1-27).

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 A, Table A.1-27).

The type of shoreline that would be contacted along the U.S. Chukchi Sea coast includes salt and brackish water marshes, mixed sand and gravel beaches and fine to medium sand beaches (Environmental Sensitivity Index, Table A.1.3).

4.5.2.7. Conclusion

A VLOS and gas release 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 cleanup, booming, beach cleaning, and monitoring.

The selection of Alternative III (Corridor I deferral, removal of 5 whole or partial blocks along the coastward edge of the Leased Area) would 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 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.

4.5.3. Air Quality

A 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 cleanup 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 buildup 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.

4.5.3.1. Winter Spill

Weather conditions in the Arctic winter are dominated by the Siberian high pressure system over central Russia, and by the semi-permanent Aleutian low, which resides over the Bering Sea (Ahrens, 2013). 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 and 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, 2013). 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 little 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.

4.5.3.2. 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 semi-permanent pressure systems, the Icelandic low over Greenland and the Pacific high positioned in the Gulf of Alaska (Ahrens, 2013). 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 dilution and diffusion of pollutants. Consequently, the most severe summertime impacts from a VLOS would likely occur within launch areas (LA) 1, 4, 5, and 6, and LA 10 and 11, where northwest winds would drive pollutants over Alaska's northwest coastline.

4.5.3.3. Black Carbon

The burning of fossil fuels creates particles of soot that are transported away from the source by the wind. 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 inland.

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 shifts and there is more incoming energy than outgoing energy. Thus, the system experiences radiative forcing, or warming (Ahrens, 2013).

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 et al., 2009). When also considering that 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 2007 FEIS (Sections IV.C.1.b; IV.C.2.b; and IV.C.3.b) (USDOI, MMS, 2007a).

4.5.3.4. 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_2, 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 NO_x 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 area designated as a Prevention of Significant Deterioration (PSD) Class II area 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 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 increasingly diluted with height and surface concentration levels would not be as high in the immediate vicinity of the fire (Evans et al., 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 contaminants of concern would include NO_x, 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 10 or 11. 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 km (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 EPA 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 2007 FEIS (Sections IV.C.1.b; IV.C.2.b; and IV.C.3.b) (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 levels of effect 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 effects could still occur along the northwest coastline.

4.5.3.5. 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 nearly all 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).

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 the type of oil that was spilt. As a general rule, emissions of VOC would be highest at the source of the spill because the rate of evaporation is influenced by the volume of oil present at the surface. However, with time the emissions would 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 would 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 evaporated 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, minor to moderate levels of effect to air quality are expected as time goes by and the oil volume decreases.

4.5.3.6. 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 volume of 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 effects to human health. 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 theOSHA 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, 2011a, Appendix B). All other sample concentrations were below the more stringent ACGIH® TLVs (U.S. Department of Labor, 2010). All measured concentrations of toluene, ethylbenzene, and xylene were within the OSHA PELs and ACGIH TLVs.

The VOC emissions from oil collecting onshore would cause a negligible to minor impact to air quality that is 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.

4.5.3.7. 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.

4.5.3.7.1. 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 will not merge with other oil 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 EPA mobilized the Trace Atmospheric Gas Analyzer (TAGA) buses that are self-contained mobile laboratories that conduct air quality monitoring (EPA, 2015). 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 these chemicals in the air along the Gulf Coast that were below the threshold that would likely cause health effects. Consequently, EPA suggests that using dispersants for oil-spill cleanup would cause a negligible impact on air quality (EPA, 2015).

4.5.3.7.2. 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_x, 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_x, 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/ m^3 when measured three miles downwind of the burning (USDOI, BOEMRE, 2011a). Considering the low concentrations of pollutants found in monitoring and modeling, and the short-term nature of in-situ burning, there would be a minor impact to air quality. Additional information concerning air quality impacts from in-situ burning is included in the 2007 FEIS (Sections IV.C.1.b; IV.C.2.b; and IV.C.3.b) (USDOI, MMS, 2007a).

4.5.3.7.3. 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 icebreakers, over the course of time required confining and removing such a large amount of 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_x, but also including CO, PM, SO_2, VOC, and CO_2 (Discovery News, 2010; EPA, 1996). Emissions from this number of vessels would likely result in temporary major levels of effect to air quality.

4.5.3.7.4. 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. Aircraft emissions are likely to cause a negligible to minor impact to air quality.

4.5.3.8. 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 that would affect local air quality. However, during the long-term recovery process, there would be continued evidence 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 would 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, minor levels of effect to air quality would be expected.

4.5.3.9. Oil-spill Trajectory Analysis

The types of impacts to air quality analyzed above would be expected to occur regardless of the location of the spill's source. An oil-spill trajectory analysis is not provided.

4.5.3.10. Conclusion

A VLOS in the Chukchi Sea could emit large amounts of regulated potentially harmful pollutants into the atmosphere. This would cause major levels of effect to air quality during some phases of the event. The greatest deterioration of air quality 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 a major impact would likely occur during these two phases, and the emissions from the VLOS would be temporary and distributed over time, air quality in the Arctic would eventually return to pre-oil-spill conditions. These impacts are not anticipated to vary under Alternatives III or IV.

4.5.4. Lower Trophic Organisms

This section assesses the potential for the hypothetical VLOS scenario described in Section 4.4.2 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. 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 4.4.2 of this document.

4.5.4.1. 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 analyzed in turn:

4.5.4.1.1. 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.

4.5.4.1.2. 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.

4.5.4.2. 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 (Hansen 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; Weingartner et al., 2013a). 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 polyaromatic compounds (PACs) 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 would 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; Iken, Bluhm, and Dunton, 2010; Hansen et al., 2011; Jiang et al., 2010; Newman and Clements, 2008; NRC, 2005b; Suter, 2007; USDOI, MMS, 2003, USDOI, MMS, 2004, USDOI, MMS, 2008).

4.5.4.3. Phase 3 (Onshore Contact)

Onshore and nearshore environments of the Chukchi Sea are summarized in the 2007 FEIS (USDOI, MMS, 2007a), 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 in 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, coarse-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 2007 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 Leased Area but near potential gas pipeline routes. Studies by Dunton and Schonberg (2000 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 two 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 analyzed in the 2011 SEIS (Section IV.E.12).

As analyzed in the 2011 SEIS (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 effects 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 BOEM (then 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 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 nearshore 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.

4.5.4.4. 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, 2005b). The application of dispersants can cause sinking of droplets and subsequent aggregation on the benthic surface (Word, Pinza, and Gardiner, 2008; NRC, 2005b) 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 would 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 would determine effects on lower trophic communities. In general, effects to phytoplankton and pelagic populations would likely be minor, but benthic and shore zone lower trophic populations could suffer greater effects of one or more years of recovery time.

4.5.4.5. 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 would 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 analyzed in earlier sections should culminate in causing population-level effects to this diverse group of organisms.

4.5.4.6. Oil-spill Percent Trajectory Analysis

The description of effects of contact and impacts should an oil spill contact lower trophic resources have been described in the preceding sections. Following is an explanation of the conditional probabilities of a chance of a large spill contacting the Lower Trophic resource ERAs.

Table 4-59. Lower Trophics – Summer or Winter Fraction of VLOS Contacting a Certain ERA.[1]

Season / Analysis Period	% Range to ERA IDs ≥0.5%	ERA IDs with any value ≥0.5%
Summer 60 days	2-24	6, 16
	2-7	7
	3-10	57
	1-2	80, 101
Summer 360 days	5-25	6, 16
	3-10	7
	3-10	57
	1-2	80, 101
Winter 360 days	4-20	6, 16
	1-1	7
	1-5	57
	1-1	80, 101
Name of ERAs Contacted: ERA 6 Hanna Shoal, ERA 7 Krill Trap, ERA16 Barrow Canyon, ERA 57 Hanna Shoal Area, ERA 80 Beaufort Outer Shelf 1, ERA 101 Beaufort Outer Shelf 2.		

Notes: [1]Lower trophics - fraction of a VLOS (expressed as a percent of trajectories) contacting a certain era within 60 or 360 days during summer or winter from any LA.

ERA 75 contacted <0.5% for all time periods and seasons. Appendix A, Tables A.2-28, 30, and 54 Maps A-2a, 2d, 2e , LA= Launch Area, ERA = Environmental Resource Area, LS = Land Segment

4.5.4.7. 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 (Pacific 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.

4.5.5. Fish

Common fish names are used in this section; the corresponding species taxonomic names are presented in in Section 4.3.5.

Very large oil spills could affect offshore and nearshore fish species in the path of or near the oil through effects such as acute toxicity or shifts in prey availability. 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.

Many journal articles have been published on the effects of the Deepwater Horizon oil spill on fish. Table 4-60 presents a summary of this journal literature. These articles document the injurious and acute effects of crude oil on the embryology, physiology, genetics, and behavior of various fish species and fish life stages.

Table 4-60. Journal Literature on the Effects of the Deepwater Horizon Oil Spill on Fish.

Title of Peer-Reviewed Article	Date	Authors
The effects of oil exposure on peripheral blood leukocytes and splenic melano-macrophage centers of Gulf of Mexico fishes	2014	Ali AO, Hohn C, Allen PJ et al.
Crude oil impairs cardiac excitation-contraction coupling in fish (1)	2014	Block B, Brette F, Cros C et al.
Crude oil impairs cardiac excitation-contraction coupling in fish(2)	2014	Brette F, Machado B, Cros C et al.
Oxidative stress responses of gulf killifish exposed to hydrocarbons from the Deepwater Horizon oil spill: potential implications for aquatic food resources	2014	Crowe KM, Newton JC, Kaltenboeck B et al.
Acute Embryonic or Juvenile Exposure to Deepwater Horizon Crude Oil Impairs the swimming performance of mahi-mahi (Coryphaena hippurus)	2014	Mager, EM, AJ Esbaugh, JD Stieglitz et al. 2014
Deepwater Horizon crude oil impacts the developing hearts of large predatory pelagic fish	2013	Incardona JP, Gardner LD, Linbo TL et al.
Influence of age-1 conspecifics, sediment type, dissolved oxygen, and the deepwater horizon oil spill on recruitment of age-0 red snapper in the Northeast Gulf of Mexico during 2010 and 2011.	2014	Szedlmayer ST, Mudrak PA.
Spatio-temporal overlap of oil spills and early life stages of fish	2013	Vikebo, Ronningen, Lien et al.
Multitissue molecular, genomic, and developmental effects of the Deepwater Horizon Oil Spill on resident Gulf killifish (Fundulus grandis)	2013	Dubansky B, Whitehead A, Miller JT et al.
Exxon Valdez to Deepwater Horizon: Comparable toxicity of both crude oils to fish early life stages	2013	Incardona JP, Swarts TL, Edmunds RC et al.
Spatial, temporal, and habitat-related variation in abundance of pelagic fishes in the Gulf of Mexico: potential implications of the Deepwater Horizon Oil Spill.	2013	Rooker JR, Kitchens LL, Dance MA et al.
Genomic and physiological footprint of the Deepwater Horizon Oil Spill on resident marsh fishes.	2012	Whitehead A, Dubansky B, Bodinier C et al.
Macondo crude oil from the Deepwater Horizon Oil Spill disrupts specific developmental processes during zebrafish embryogenesis	2012	de Soysa TY, Ulrich A, Friedrich T et al.
Response of coastal fishes to the Gulf of Mexico Oil disaster	2011	Fodrie FJ Heck KL, Jr.
Potential impacts of the Deepwater Horizon Oil Spill on large pelagic fishes	2011	Frias-Torres S, Bostater JC

4.5.5.1. 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 release 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 (GESAMP, 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.

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 (164 ft)) 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.

4.5.5.2. 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 VLOS 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 release:

- 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

Information for the bulleted list above was obtained from: Nahrgang et al., 2010a,b,c; Boertmann, Mosbech, and Johansen, 1998; Jonsson et al., 2010; Pearson, Woodruff, and Sugarman, 1984; Pinto, Pearson, and Anderson, 1984; Moles and Wade, 2001; Heintz et al., 2000; Patin, 1999; Christiansen and George, 1995; Christiansen et al., 2010; Mahon, Addison, and Willis, 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 4.5.3 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 4-61 are those that have been reported to and documented by the Alaska Department of Fish and Game through the Alaska Anadromous Waters Catalog (ADF&G, 2014a). 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. 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 53 anadromous waterbodies listed in Table 4-61, 31 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 (850 mi) of discontinuous shoreline length could be contacted by oil depending on location of a VLOS, the season and the number of days after the spill release (see OSRA model results below).

Table 4-61. Anadromous Waters in Northwest Alaska from Bering Strait to Nuiqsut.

River/Stream Name	Anadromous Fish Species
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	Anadromous Fish Species
Kougachk Creek	Pink salmon
Kugrua River	Chum salmon, Pink salmon
Kuchiak Creek	Chum salmon, Coho salmon
Kuk River	Pink salmon, Chum salmon, Bering cisco, Least cisco, Rainbow smelt
Kukpowruk River	Chum salmon, Dolly Varden
Kukpuk River	Pink salmon
Kukukpilak Creek	Dolly Varden
Lewis River Channel	Chum salmon, King salmon, Pink salmon, Dolly Varden, 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, Dolly Varden
Yankee River	Dolly Varden
Kaolak River	Chum salmon
Avalik River	Chum salmon, Pink salmon
Ketik River	Chum salmon, Pink salmon
Avak Creek	Sockeye salmon, Broad Whitefish, Least cisco
Ikroagvik Lake	Sockeye salmon, Broad Whitefish, Least cisco
Unnamed Trib. in Kuk River Basin	Chum salmon
Unnamed Trib. in Kuk River Basin	Least cisco
Unnamed Trib.in Kuk River Basin	Least cisco
Reed River	Chum salmon
Mauneluk River	Chum salmon, whitefish
Kungok River	Chum salmon, Pink salmon, Broad whitefish, Least cisco, Rainbow smelt
Mikigealiak River	Chum salmon, Pink Salmon, Least cisco

Source: Alaska Department of Fish and Game, 2013

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.

Acute and chronic effects of oil on nearshore and intertidal fish, eggs, and larvae can have cascade effects on fish populations over time. 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, Woodruff, and Sugarman, 1984; Pinto, Pearson, and Anderson, 1984; Moles and Wade, 2001).

Offshore fish species would experience a variety of effects from a VLOS 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., 2010; 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 the 2011 SEIS (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 (Tables 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.

The 2011 SEIS (Appendix C, Table C-1) 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 VLOS, from the time of explosion (Phase 1), to offshore and onshore contact (Phases 2 and 3) and the response, cleanup and long-term recovery (Phases 4 and 5).

4.5.5.3. Phase 3 (Onshore Contact)

As previously explained, analysis of potential effects on fish during both Phases 2 and 3 of the VLOS scenario are analyzed together within Phase 2.

4.5.5.4. Phase 4 (Spill Response and Cleanup)

4.5.5.4.1. 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, Pinza, and Gardiner, 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, Pinza, and Gardiner, 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, Pinza, and Gardiner, 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 VLOS 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.

4.5.5.4.2. 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/oil-and-chemical-spills/oil-spills/resources/in-situ-burning.html).

4.5.5.4.3. 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 icebreaker 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 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 possibility that invasive species could be 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). Icebreakers would cause disturbance to ice habitat, and depending on the time of year, could affect the eggs and young larvae or Arctic cod.

4.5.5.4.4. 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 drilling offshore wells on water quality and fish are analyzed in Section 4.3.5.

4.5.5.4.5. 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.

4.5.5.4.6. 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.

Furthermore, as result of environmental stress and changes resulting from oil spills and a warming environment due to climate change, previously unknown fish populations could move into a new areas and complicate recovery (Cheung et al., 2009).

The 2011 SEIS (Appendix C, Table C-1) 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 VLOS, from the time of explosion (Phase 1), to offshore and onshore contact (Phases 2 and 3) and the response, cleanup and long-term recovery (Phases 4 and 5).

4.5.5.5. Oil-spill Trajectory Analysis

The following paragraphs present results estimated by the OSRA model from a VLOS 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 A, Section A-7). 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 and fish habitat. 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.

4.5.5.5.1. Summer within 60 and 360 Days

The OSRA model estimates the percent of trajectories contacting the following areas important to fish, within 60 days and/or 360 days during summer:

- Four Environmental Resource Areas: Saffon cod EFH, Opilio crab EFH, Arctic cod EFH, and Pacific salmon marine EFH in the U.S. Chukchi Sea
- One Grouped Land Segment: Kuk River, along the U.S. Chukchi Sea coast
- Seven Land Segments along the U.S. Chukchi Sea coast: Sulupoaktak Channel, Kukpowruk River, Kokolik River, Utukok River-Kasegaluk Lagoon, Kugrua River
- Two Land Segments along the Russia Chukchi Sea coast: Amguema River, Kolyuchinskaya Bay, Chegitun River
- Twenty Boundary Segments in the Northeast Chukchi Sea; 4 Boundary Segments in the northern Beaufort Sea

4.5.5.5.2. U.S.- Alaska: Summer, 60 and 360 Days

The OSRA model estimates that during summer the percent of trajectories contacting seven U.S. Alaska coastal land segments with important fish resources from any LA is 1-4% (Table 4-62) within 60 and 360 days. The majority of trajectories would result primarily from three nearshore PLs (3,6,9) and two offshore LAs (10 and 11).

Table 4-62. Fish-Summer Fraction of VLOS Contacting a U.S. LS Within 60 or 360 Days.[1]

	Season / Analysis Period	% Range to Land Segments ≥0.5%	Fish: Coastal Land Segments with any value ≥0.5%
Alaska	Summer 60 days	1-4 %	64,67, 70, 71, 72, 74, 80
Alaska	Summer 360 days	1-4 %	64, 67, 70, 71, 72, 74, 80
Geographic Name of Land Segments Contacted in Alaska: LS64 Aiautak Lagoon, Ipiutak Lagoon, Kowtuk Point, Kukpuk River, Pingu Bluff, Point Hope, Sinigrok Point, Sinuk; LS71 Kukpowruk River, Naokok, Naokok Pass, Sitkok Point; LS72 Epizetka River, Kokolik River, Point Lay, Siksrikpak Point; LS74 Kasegaluk Lagoon, Solivik Island, Utukok River; LS80 Eluksingiak Point, Igklo River, Kugrua Bay.			

Notes: [1]Fish-Fraction of a VLOS (expressed as a percent of trajectories) From Any Launch Area Contacting Certain Land Segments Within 60 or 360 Days From a Summer VLOS.

Appendix A, Tables A.2-34, 36, 60, Map A-3b, LA= Launch Area, LS = Land Segment.

The anadromous water bodies important to fish that have a percent of trajectories contacting ≥ 1% include: Kukpuk River-Sulupoaktak Channel, Kukpowruk River, Kokolik River, Utukok River-Kasegaluk Lagoon, Pitimegea River, Kuchiak Creek, Kuchaurak Creek, and Kugrua River. The anadromous species that occur in these water bodies are shown in Table 4-61.

The percentage of trajectories contacting Kuk River (GLS 151) is 1-8% within 60 and 360 days during summer. The highest percent of trajectories contacting Kuk River would result primarily from three nearshore PLs (3,6,9) and two offshore LAs (10 and 11).

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 encompasses an estuary important to rearing fish, including out-migrating salmon smolts from the Kukpowruk, Kokolik, and Utukok rivers.

Capelin and sand lance use beaches throughout the northeastern Chukchi Sea for spawning. Shoreline habitats are predominantly fine-to medium-grained sand beaches or mixed sand and gravel beaches between Point Hope (LS 64) and Skull Cliffs (LS 82) (Appendix A, Table A.1-3).

The OSRA model estimates that 1-5% of trajectories contact 20 Northeast Chukchi Sea Boundary Segments (BSs), and 4 Beaufort Sea BSs; these segments extend beyond the 200 nmi (230 mi or 370 km) exclusive economic zone (EEZ). This pelagic area ranging out to and past the EEZ is habitat for epipelagic fish including early life stages and adults of Arctic cod, adult and juvenile Pacific salmon, migratory Dolly Varden, adult capelin, and other epipelagic early life stages of fish species. These trajectories would also contact large areas of the currently designated EFH for Arctic cod, and the marine EFH for Pacific salmon.

The percent of trajectories contacting Saffron cod EFH is 12-68% and 13-68% within 60 and 360 days, respectively from all LAs during summer. The percent of trajectories contacting Opilio crab EFH is 1-8% within 60 and 360 days during summer The highest percent of trajectories contacting saffron cod or opilio crab EFH results primarily from three nearshore PLs (3,6,9) and two offshore LAs (10 and 11).

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 A, Table A.1-27). 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.

4.5.5.5.3. Russia Far East Coastline: Summer, 60 and 360 Days

The OSRA model estimates that 1-2% of trajectories any LA contact three Russia Far East coastal land segments with important fish resources within 60 and 360 days (Table 4-63). The anadromous waters within these three land segments include: Amguema River, Kolyuchin Bay, and Chetigun River. The Russia Far East coast has many coastal rivers, lagoons and bays with habitat that support fish. King, sockeye, coho, chum and pink salmon, whitefish, Dolly Varden, least cisco, Bering cisco, rainbow smelt, and Arctic char have been documented in coastal waters from Uelen Lagoon to Koluychin Bay.

Table 4-63. Fish–Summer Fraction of VLOS Contacting a Russia LS Within 60 or 360 Days.

Region	Season / Analysis Period	% Range to LSs ≥0.5%	Fish: Coastal Land Segments with any value ≥0.5%
Russia Far East	Summer 60 days	1-2 %	25, 31, 37
Russia Far East	Summer 360 days	1-2 %	25, 31,37
Geographic Name of Fish Resouce Land Segments Contacted in Far East Russia: LS25 Laguna Amguema, Ostrov Leny, Yulinu; LS31 Alyatki, Zaliv Tasytkhin, Kolyuchin Bay; LS 37 Chetigun River.			

Notes: Fish–Fraction of a VLOS (expressed as a percent of trajectories) from Any Launch Area Contacting a Certain Land Segment Within 60 or 360 Days During Summer.

Source: Appendix A, Tables A.2-34, 36, 60, Map A-3a, 3b, LA= Launch Area, LS = Land Segment. Coastal Far East Russia.

4.5.5.5.4. Alaska and Far East Russia: Winter, 360 Days

The OSRA model estimates that a percent of trajectories from any launch area would contact the following areas important to fish within 360 days during winter:

- Four Environmental Resource Areas in the U.S.: Saffon cod EFH, Opilio crab EFH, Arctic cod EFH, and Pacific salmon marine EFH
- One Grouped Land Segment: Kuk River, along the U.S. Chukchi Sea coast

- Five Land Segments along the U.S. Chukchi Sea coast: Kukpuk River-Sulupoaktak Channel, Utukok River-Kasegaluk Lagoon, Pitmegea River, Kokolik River, Kugrua River,
- Five Land Segments along the Russia Chukchi Sea coast: Amguema River, Kolyuchinskaya Bay, Chegitun River, Inchoun Lagoon, Uelen Lagoon
- Twenty Boundary Segments in the Northeast Chukchi Sea; 4 Boundary Segments in the Beaufort Sea; 2 Boundary Segments in the Bering Strait

4.5.5.5.5. Alaska Coastline: Winter

Table 4-64 presents the percent of trajectories contacting the Alaska or Russian Far East coastline within 360 days during winter. The OSRA model estimates the percent trajectories contacting five land segments in the Alaska coastline is 1-3% within 360 days during winter. The highest percent of trajectories result from three nearshore PLs (3,6,9) and one offshore LA (11). The anadromous water bodies important to fish that have a percent of trajectories contacting include: Kukpuk River-Sulupoaktak Channel, Pitimegea River, Kokolik River, Utukok River-Kasegaluk Lagoon, and Kugrua River. The highest percent of trajectories contact Kokolik River and Kugrua Bay. The anadromous species that occur in these water bodies are shown in Table 4-61.

Table 4-64. Fish-Winter Fraction of VLOS Contacting a Certain LS Within 360 Days.[1]

Region	Season / Analysis Period	% Range to LS ≥0.5%	Fish: Coastal LS with any value ≥0.5%
Alaska	Winter 360 days	1-3 %	64,67, 72,74, 80
Russian Far East	Winter 360 days	1-5%	25, 31,37, 38, 39
Geographic Name of Land Segments Contacted: LS64 Kukpuk River Aiautak Lagoon, Ipiutak Lagoon, Kowtuk Point, Pingu Bluff, Point Hope, Sinigrok Point, Sinuk; LS 67 Pitmegea River, Cape Sabine; LS 72 Kokolik River, Point Lay; LS74 Utukok River- Kasegaluk Lagoon, Solivik Island; LS80 Kugrua Bay Igklo River, Eluksingiak Point; LS25 Laguna Amguema, Ostrov Leny, Yulinu; LS31 Kolyuchin Bay Alyatki, Zaliv Tasytkhin,; LS37 Chevgtun, Utkan, Mys Volnistyy; LS38 Laguna Inchoun, Enmytagyn, Inchoun, Inchoun Mitkulino, Uellen, Mys Unikin; LS 39- Uelen, Laguna Uelen, Mys Uelen, Mys Inchoun, Mys Peek, Naukan, Cape Dezhnev.			

Notes: [1]Fish–Fraction of a VLOS (expressed as a percent of trajectories) From Any Launch Area that Contacts a Certain Land Segment Within 360 Days During Winter.

Appendix A, Tables A.2-34, 36, 60, Map A-3b, LA= Launch Area, LS = Land Segment.
Alaska or Far East Russia

Kuk River (Grouped Land Segment 151) would be contacted by 1-4% of trajectories within 360 days of a winter VLOS. The majority of trajectories contacting Kuk River from a winter VLOS would result primarily from two nearshore pipeline launch areas (PL 3,6) and one offshore launch areas (LA 11).

The OSRA model estimates that 1-6% of trajectories contact 20 Northeast Chukchi Sea Boundary, and 1% of the trajectories contact 4 Beaufort Sea Boundary Segments. These segments extend beyond the 200 mi (230 mi or 370 km) exclusive economic zone (EEZ). The pelagic area ranging out to and past the EEZ is habitat for epipelagic fish including early life stages and adults of Arctic cod, adult and juvenile Pacific salmon, migratory Dolly Varden, adult capelin, and other epipelagic early life stages of fish species. These trajectories would also contact large areas of the currently designated EFH for Arctic cod, and the marine EFH for Pacific salmon.

The percent of trajectories contacting Saffron cod essential fish habitat (EFH) is 6-61% within 360 days during winter. Opilio crab EFH is contacted by 2-16% of trajectories within 360 days. The highest percent of trajectories contacting saffron cod or opilio crab EFH results primarily from three nearshore PLs (3,6,9) and two offshore LAs (10 and 11).

A 60,000 bbl oil spill that occurs 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 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 A, Table A.1-27).

The OSRA trajectory model estimates the trajectories of a surface oil spill; it does not, however, assess subsurface transport of oil or the fate or persistence of oil once it has reached spawning beaches, rearing areas or spawning streams. PAHs in weathered oil can persist in these spawning and rearing habitats for long periods and remain as a source of acute or chronic toxicity to sensitive life stages. There are several locations where oil may contaminate substrates in estuarine, intertidal and coastal- freshwater habitats that are used for spawning and rearing fish populations such as pink salmon, chum salmon and capelin (Table 4-61).

4.5.5.5.6. Russia Far East Coastline: Winter

The range of percent trajectories contacting five Russia Far East coastline during a winter VLOS within 360 days is 1-5% (Table 4-63). The segment with the highest percent of trajectories contacting is Kolyuchin Bay (LS 31) where up to 5% of trajectories contact the bay from areas all LAs.

The Russia Far East coast has many coastal rivers, lagoons and bays with habitat that support fish. King, sockeye, coho, chum and pink salmon, whitefish, Dolly Varden, least cisco, Bering cisco, rainbow smelt, and Arctic char have been documented in coastal waters from Uelen Lagoon to Koluychin Bay.

4.5.5.6. Conclusion

The impacts of a VLOS 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 salmon, saffron cod, Arctic cod, sand lance, capelin, nearshore sculpin species, nearshore flounders and plaice, migratory least cisco, migratory Dolly Varden, migratory Arctic char, rainbow smelt, stickleback, and migratory whitefish. Other fish species that would be affected by a VLOS include: herring, coho, sockeye and king salmon, snailfish, eelblennies, eelpouts, poachers, offshore sculpin, lamprey, and alligatorfish.

4.5.6. Marine and Coastal Birds

A 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 this SEIS.

Effects of a VLOS on marine and coastal birds are analyzed 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. Long-term recovery of most populations could occur, but most species would require more than three generations and access to unaffected/restored habitats for this to occur.

4.5.6.1. 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 effects on marine and coastal birds are anticipated.

4.5.6.2. 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 waterbirds 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. Species are categorized and analyzed below according to their level of potential for substantial effects.

4.5.6.2.1. 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 several 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 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 VLOS 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 VLOS 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 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, et al., 2011). A large majority of Kittlitz's murrelets in the eastern

Chukchi Sea could be killed if oil were to contact them in coastal areas. This species is widespread in low numbers throughout Alaska and birds offshore of the North Slope are at the outer range of the species distribution. Recovery would depend on dispersal from other areas, 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 Sea 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). 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 several 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 VLOS 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 several 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 several 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 VLOS scenario, a VLOS 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 several 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. 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 (37 mi) 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.

4.5.6.2.2. 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 VLOS (Powell, Taylor, and Lanctot, 2010).

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.

4.5.6.2.3. Birds with a Lower Potential for Substantial Effects

The birds analyzed below spend less time in direct contact with water and, therefore, the potential for substantial effects is considerably lower than for seabirds, waterfowl, and shorebirds 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 VLOS 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.

4.5.6.3. 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.

4.5.6.4. 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.

4.5.6.5. Phase 5 (Long-term Recovery)

Long-term describes an impact producing factor that continues to produce effects in populations for more than two 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, 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.

4.5.6.6. Oil-spill Trajectory Analysis

The potential impacts to marine and coastal bird species during each phase of the hypothetical scenario are addressed above. BOEM now uses 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 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 described in Appendix A and Maps A-2a-f. The ERAs important to marine and coastal birds are summarized in Appendix A, Tables A.1-9 and A.1-10. The vulnerability of an ERA is based on the seasonal use patterns of marine and coastal birds using the area (Appendix A, Tables A.1-9 and A.1-10).

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.

Under a hypothetical VLOS scenario, the OSRA model estimates that ≥1% of spill trajectories from any individual LA could contact ERAs important to birds within 60 or 360 days during the summer or winter (Table 4-65).

Table 4-65. Birds-Summer or Winter Fraction of VLOS Contacting a Certain ERA.[1]

Season / Analysis Period	% Range to ERAs ≥0.5%	ERA IDs with any value ≥0.5%
Summer 60 days	1-29	1, 2, 10, 14, 15, 18, 19, 64
Summer 360 days	1-29	1, 2, 10, 14, 15, 18, 19, 64
Winter 360 days	1-12	10, 15, 18, 19, 64
Name of ERAs Contacted: 1-Kasegaluk Lagoon Area; 2- Point Barrow, Plover Islands; 10- Ledyard Bay SPEI Critical Habitat Area; 14- Cape Thompson Seabird Colony Area ; 15- Cape Lisburne Seabird Colony Area ; 18- Murre Rearing and Molting Area ; 19- Chukchi Sea Spring Lead System; 64- Peard Bay Area.		

Notes: Marine and Coastal Birds - Fraction of a VLOS (expressed as a percent of trajectories) Contacting a Certain ERA Within 60 or 360 Days During Summer or Winter from Any LA.

Appendix A, Tables A.2-28, 30, 54, Maps A-2a-f, LA= Launch Area, ERA = Environmental Resource Area.

4.5.6.6.1. Summer Spill

Under a hypothetical VLOS scenario for summer, the OSRA model estimates that ≥1% of spill trajectories from any individual LA could contact ERAs important to birds within 60 or 360 days during the summer (Table 4-65).

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 29% of trajectories from a hypothetical VLOS originating from LA 10 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 9% from LA10 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) within 60 and 360 days was 21% from LA11.

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 was 13% from LA10 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 <0.5-1% of trajectories from any LA contact spectacled eiders and other seabirds staging offshore Barrow in the Plover Islands (ERA 2) within 60 or 360 days during summer.

The Chukchi Sea spring lead system (ERA19) 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. Within 360 days, however, 8% of trajectories from LAs 10 or 11 are estimated to contact the Chukchi 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 percentages of trajectories from a hypothetical VLOS that could contact ERA 18 were 19% and 20% from LA10 within 60 and 360 days, respectively.

4.5.6.6.2. Winter Spill

The OSRA model estimates that 12% of trajectories from a VLOS starting at any LA could contact habitats (ERAs) that are important to marine and coastal birds (Table 4-65). The OSRA model estimates that 3% of trajectories from a hypothetical VLOS originating from LA10 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 Area 19 makes 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 this ERA is 12% from LA11 during winter within 360 days. 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.

The OSRA estimates <0.5% 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 could 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 3% of trajectories from a hypothetical VLOS from LA10 could contact Peard Bay (ERA 64) or <0.5% for Kasegaluk Lagoon (ERA 1) within 360 days, during winter.

Trajectories from a hypothetical VLOS during winter, within 360 days had an estimated 1-8% contact with the pelagic murre molting area (ERA 18) from any LA.

4.5.6.7. 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 system
- 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 loons, seabirds, and waterfowl including listed eiders. 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.

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 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 10 and 11) 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 additional 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.

4.5.7. Marine Mammals

Impacts to marine mammals from a hypothetical VLOS were analyzed in the 2011 SEIS (Sections IV.E.7, IV.E.10 and IV.E.11). This analysis found that marine mammals could experience mortality, long term sublethal impacts, and impacts to prey availability from such an event. No additional information has become available that would alter the conclusions of that analysis.

4.5.7.1. Cetaceans

A VLOS originating in the Leased 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, population size, distribution and habitat selection are species specific, which puts some species at greater risk than others of contact from a VLOS.

Effects of a VLOS on each cetacean species are analyzed 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 Leased Area. Refer to the 2007 FEIS (Section IV.C.1.f(1)(g) (pp. IV-114 to IV-122)) and this Second SEIS Section 4.3.7 for detailed discussion of the potential effects of oil on 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 would likely 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 vary, and require access to unaffected/restored habitat during the recovery period.

4.5.7.1.1. 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 effects on cetaceans, with the exception of individuals experiencing hearing injuries, bodily injuries, or mortality 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 analyzed in Phase 2 and Phase 4, respectively. Potential IPFs 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 TTS or 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 impacts. The explosion could cause non-lethal and temporary effects in the form of a startle response. Startle events (McCauley et al., 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 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.

Redistribution 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 sunken rig 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 a damaged rig; however, such compounds would be in limited quantities, rapidly dilute or disperse, settle to the sea floor, or be recovered. Depending on compound chemical properties, localized fate of the compound, and capability for cleanup of 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, 1995:284-289).

4.5.7.1.2. 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 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 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 2007 FEIS (USDOI, MMS, 2007a).

This analysis will address each of these potential effects for each species of cetaceans using the Chukchi Sea.

Bowhead Whale (Endangered)

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 et al., 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, Krogman, and Carroll, 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 Leased Area (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 and Van Schoik, 1982, 1986, 1987; Brueggeman et al., 1991, 1992). 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 (Huntington and Quakenbush, 2009, Figure 26). 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. Clarke et al. (2014) noted bowhead whale feeding areas in the Canadian Beaufort Sea, and Rugh et al. (2014) observed bowhead feeding areas in the vicinity of Barrow Canyon and Barrow, Alaska.

Contact with Oil

Bowheads are the most likely of the ESA-listed baleen whales to experience effects of a VLOS as described in the Scenario since they are common in the Chukchi and Beaufort Sea waters during their migrations (Harwood et al., 2010; Quakenbush, Small, and Citta, 2010). Acoustic studies suggest some bowheads inhabit the Chukchi Sea year-round; however, most bowheads migrate to the Bering Sea to overwinter (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; Moore et al., 2010).

Nothing indicates the impacts in this case would differ between 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 measured 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 varies and is controversial due to lack of carcasses for necropsy. Thus, predicting potential long-term sublethal effects (reduced body condition/ health/ productivity/fitness, etc.) or lethal effects on cetaceans from a VLOS is problematic.

The greatest threat to large cetaceans would be inhalation of fresh oil toxic hydrocarbons fractions. Prolonged inhalation of volatile toxic hydrocarbon fractions of fresh oil induces severe 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 VLOS. 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 (NORCOR, 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 Sea 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 VLOS. 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 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 BOEM 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 seafloor 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 effect 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 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 remain undocumented; however, bowhead whales 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. Bowhead whales may or may not 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. Additional 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 VLOS 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 analyzed in the 2011 SEIS (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 Leased 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, nor 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 Brower (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 bowhead whales have well-developed olfactory organs (Thewissen et al., 2010), and could detect spilled oil to such a degree that they may modify movements to avoid a VLOS.

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 are sufficient to prove cetaceans can detect oil and avoid it, or if 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 (Würsig et al., 1985, as cited in Bratton et al., 1993; Clarke et al., 2014). Such observations suggest oil present on the sea surface in recognizable quality or quantity may be recognizable and avoidable by bowhead whales (Bratton et al., 1993). However, the observation of their playing with dye could also indicate inability to 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, 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 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 (Endangered)

Fin whales are present during the open-water season in the Chukchi Sea. These whales are rare in the Leased Area (Funk et al., 2010; COMIDA, 2009; Roseneau, 2010), and are more common in the southwestern Chukchi Sea near Chukotka, Russia. Fin whales are widespread and more abundant in the Bering Sea (Melinger et al., 2010). Their similarities to bowhead whales suggest they should experience effects similar to bowheads from VLOS exposure. 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. Likewise fin whales could exhibit the ability to detect and avoid of spilled oil for the same reasons bowhead whales might. Available data following both the EVOS and the Glacier Bay, Alaska oil spills, indicate it is unlikely large numbers of fin whales would be affected by a VLOS from the Leased Area.

Because of their frequency of occurrence and distribution in the Chukchi Sea the primary areas for effect of a VLOS on fin whales would occur in the waters of the Chukchi Sea off Chukotka, especially near Cape Dezhnev in the summer, or in waters south of Cape Lisburne, Alaska.

Humpback Whale (Endangered)

Humpback whales are present during the open-water season in Chukchi Sea coastal waters and far western Beaufort Sea, but rarely occur near the Leased Area (Clarke et al., 2014). They are regularly observed in waters of the southwestern Chukchi Sea adjacent to the Chukotka Peninsula, south of Cape Lisburne, and occasionally in Peard Bay, Alaska. 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 Leased Area. However, if the humpback whales in the Leased Area and adjacent Chukchi Sea originate from the Western North Pacific stock (a smaller and less well-understood stock), any injuries or losses of individuals could produce important population level effects. 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 analyzed in previous paragraphs, literature on the effects of crude oil on mammals indicates humpback whales could be vulnerable to such spills.

Because of their scarcity and distribution, the greatest effects on humpback whales would be from a VLOS contacting waters adjacent to the Chukotka Peninsula, or south of Cape Lisburne, Alaska. In summer and fall, humpback whales could be negatively affected by a VLOS contacting waters off the northern Chukotkan coastline, especially near Cape Dezhnev. Considering the rapidly changing Arctic and the increasing length of the open-water season, increases in humpback whale numbers and use of the Chukchi Sea are foreseeable. If the Chukchi Sea becomes more accommodating to humpback whales greater numbers of humpbacks may use Chukchi Sea habitat, and the effects of a VLOS on the humpback whale population could increase. Previous paragraphs noted literature on crude oil effects on mammals suggests humpback whales could be vulnerable to such a VLOS. Though there is no evidence humpbacks were negatively impacted by the EVOS (von Zeigesar, Miller, and Dahlheim, 1994), the EVOS occurred before most migrating humpback whales arrived 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, Shelden, and Schulman-Jainger, 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, Moore, and Ljungblad,1989; Brueggeman et al., 1992; Funk et al., 2010; Goetz et al., 2009). They are the most abundant cetacean reported in the Chukchi Sea during summer (Funk et al., 2010; Brueggeman et al., 1992) and widespread. Gray whales often use nearshore habitat (< 40 km or 25 mi from shore) with highest concentrations north and east of Wainwright, and most occurred between Wainwright and Cape Belcher during the 2008 and 2009 survey seasons (Brueggeman, 2010). More recent ASAMM sighting data in Clarke et al. (2014) supports the earlier surveys, indicating large gray whale concentration areas from Wainwright to Barrow in nearshore waters.

Recent acoustic data suggest some gray whales may over-winter in the Chukchi Sea (Stafford et al., 2007), but the numbers are probably small (Moore, DeMaster, and Dayton, 2000). 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., 2009b), and 2009-2010 COMIDA surveys (COMIDA, 2009; 2010) found most gray whales feeding nearshore between Point Lay and Barrow from June to October. Rugh et al. (2014) noted gray whales feeding in the vicinity of Barrow Canyon, with some individuals feeding to the west of Point Barrow, Alaska.

Gray whale movements vary annually depending on prey abundance and distribution (Nerini, 1984). Gray whales feed in soft sediments which support 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 Leased Area between 160º and 165º W, but none were seen there during the 2009 and 2010 COMIDA surveys (Clarke et al., 2011); however, two were seen in the vicinity of Hanna Shoal during ASAMM surveys suggesting a few gray whales still frequent the Hanna Shoal area (Clarke et al. 2014).

Contact with Oil

Gray whales are present in the Chukchi Sea and far western and eastern Beaufort Sea (Rugh, 1981; Moore, DeMaster, and Dayton, 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 analyzed 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 as 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 Sea. 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 seafloor 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 affect gray whales by contaminating benthic prey and sediments (please refer to the 2011 SEIS (Section IV.E.4)), particularly in prime feeding areas (Würsig, 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 nearshore 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 (2011 SEIS (Section IV.E.5)). 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 Leased Area. Minke whales contacting oil could experience temporary and non-lethal effects within the Leased Area.

Contamination and Reduction of Food Sources

These whales prey on schools of forage fish species (see the 2011 SEIS, 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, Lowry, and Frost, 2005; Roseneau, 2010). Some belugas migrate through the Chukchi Sea 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, 2014c). 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, Lowry, and Frost, 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 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 Sea coast used by belugas for migration, moulting and nursing are vulnerable to oil contamination and subsequent ingestion by large numbers of beluga whales (see the 2011 SEIS (Section IV.E.5)).

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 the 2011 SEIS (Section IV.E.5)).

Displacement From and Avoidance of Habitat

The presence of oil could displace belugas from, or 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 activities (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, Yurk, 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, Lowry, and Burns, 1983; Lowry, Nelson, and Frost, 1987; 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 analyzed 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 would determine the persistence and use of the Leased 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 would determine the persistence and use of the Leased 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 Sea 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 would determine the persistence and use of the Leased Area and adjacent areas (see the 2011 SEIS (Section IV.E.5)).

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 would determine the persistence and use of the Leased 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 if; or even after, prey populations become restored (see the 2011 SEIS (Section IV.E.5)).

4.5.7.1.3. 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.

4.5.7.1.4. Phase 4 – Oil-spill Response, Cleanup, Restoration, and Remediation

Oil-spill response, cleanup, restoration, and remediation (Phase 4) has the potential to 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 Leased 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 icebreakers, 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 the 2007 FEIS (Section IV.C.1.f(1)(pages IV-80-116)) 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 2007 FEIS (Section IV.C.1.h. (pages IV-149 through IV-156)) 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 analyzed for each. Thorough discussion of potential impacts to the endangered bowhead whale will often serve to introduce concepts applicable to other species.

Bowhead Whale (Endangered)

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, and 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 (0.62 mi) from the vessel. Therefore, bowheads would likely avoid the vessels at a distance of over 1 km (0.62 mi); 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 (<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 cleanup 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, 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, 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 cleanup 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. Relief well drilling operations are likely to employ drilling vessels (with icebreaker 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 Leased 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 MODUs 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 and disturbance from vessel presence and activity, and noise and disturbance from aircraft, as well as the 2007 FEIS (Section IV.C.1.f(1)(d)) for detailed discussions of effects from these similar support activities associated with relief well drilling efforts.

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 MODUs 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 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 onshore (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 analyzed above under sections for noise and disturbance from vessel presence and activity, and noise and disturbance from aircraft, as well as within the 2007 FEIS (Section IV.C.1.f(1)(d)(3) - Effects of Noise from Icebreakers; Section IV.C.1.f(1)(d)(4) - Effects from Other Vessel Traffic Associated with Seismic Surveys; and Section IV.C.1.f(1)(d)(5) - Effects from Aircraft Traffic) (USDOI, MMS, 2007a). 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 the 2007 FEIS (Section IV.E.4). Overall it is possible that the use of dispersants, if permitted, could lead to effects through either reduction of food availability, bio-accumulation, or contamination. The same would be true for any cetacean.

Fin Whale (Endangered)

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 (Endangered)

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 are used to break up surface oil 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. 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 (2000a) 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 onshore (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.

4.5.7.1.5. 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 analyzed 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. BOEM 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 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 (Endangered)

Bowhead whales 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 (Endangered)

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 (Endangered)

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 1980s and 1990s 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, 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.

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.

4.5.7.1.6. Oil-spill Trajectory Analysis

A hypothetical VLOS could contact offshore areas when and where 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 6 launch areas (LAs). The LAs are shown in Appendix A, Map A-5.

This section describes the results estimated by the OSRA model for a hypothetical VLOS originating within 6 LAs in the Leased 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 (Appendix A, Table A.1-11). For the purpose of this analysis, the hypothetical initial event for a VLOS 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 (Endangered)

Summer Spill. The OSRA model estimates that trajectories from LAs could contact ERAs important to bowhead whales. The OSRA model results, unless otherwise noted, are expressed as percent of spill trajectories contacting within 60 and 360 days during summer, and 360 days during winter (Table 4-66).

ERAs 21-29 and 108 represent the fall migration corridor and periodic fall feeding aggregations for bowheads in September and October. ERAs 30, 31, 49, 53, and 54 represent the Beaufort and Chukchi Sea spring leads used April thru June by migrating bowhead whales. ERA 56 represents a August thru October use area for bowhead whales. ERAs 73, 70, 74, and 122-124 are October thru December use areas, and ERAs 61, 82, and 83 are feeding and migration areas for bowheads. ERAs not described had <0.5% chance of contact.

Winter Spill. Winter spills, which include fresh oil entering the marine environment after October 31, within 60 days, contact ERAs through which bowhead whales migrate in late fall across the Chukchi Sea during the month of November.

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 Sea spring lead systems (ERAs 49, 53, and 54) 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) could become trapped in ice and gradually released over winter and spring. Much of the toxic aromatic hydrocarbon components would have had the winter 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.

Table 4-66. Bowhead Whales–Summer or Winter Fraction of VLOS Contacting an ERA.[1]

Season / Analysis Period	% Range to ERAs ≥0.5%	ERA IDs with any value ≥0.5%
Summer 60 days	1-2	20, 30, 31
	1-1	27, 28, 29, 109
	1-11	49, 53, 54
	8-33	56
	16-54	61
	1-5	63, 70, 74
	1-10	82, 83, 122
	3-4	91
	2-6	108
	3-8	123, 124
Summer 360 days	1-2	20, 30, 31
	1-1	27, 28, 29,109
	1-11	49, 53, 54
	8-35	56
	17-55	61
	1-5	63, 70, 74
	1-10	82, 83, 122
	3-6	91
	2-6	108
	4-9	123, 124
Winter 360 days	1-3	20, 30, 31, 56, 61, 63, 70, 91
	1-17	49, 53, 54
	1-5	74
	1-2	122
	1-9	123, 124
Name of ERAs Contacted ERA1 Kasegaluk Lagoon Area; ERA27 AK BFT Bowhead FM 6; ERA28 AK BFT Bowhead FM 7; ERA29 AK BFT Bowhead FM 7; ERA30 Beaufort Spring Lead 1; ERA31 Beaufort Spring Lead 2; ERA 49 Chukchi Sea Spring Lead 1; ERA 53 Chukchi Sea Spring Lead 2; ERA54 Chukchi Sea Spring Lead 3; ERA56 Hanna Shoal Area; ERA61 Pt Lay-Barrow BH GW SFF; ERA63 North Chukchi Sea; ERA70 North Central Chukchi Sea; ERA74 Offshore Herald Island; ERA82 N Chukotka Nrshr 2; ERA83 N Chukotka Nrshr 3; ERA91 Hope Sea Valley; ERA108 Barrow Feeding Aggregation; ERA109 AK BFT Shelf Edge; ERA122 North Chukotka Offshore; ERA123 AK Chukchi Sea Offshore; ERA124 Central Chukchi Sea Offshore.		

Notes: Bowhead Whales - Fraction of a VLOS (expressed as a percent of trajectories) Contacting a Certain ERA within 60 or 360 Days during Summer or Winter from any LA.

Appendix A, Tables A.1-11, A.2-28, 30, and 54, Maps A-2a through 2f , LA= Launch Area, ERA = Environmental Resource Area.

Fin Whale (Endangered)

Summer Spill. Fin whales are present only during the open-water season and could mostly be affected by VLOS during this season. They occur in very low numbers and are widely distributed in the U.S. Chukchi Sea with greater abundances occurring south of Cape Lisburne and in Russian waters. Few fin whales have been observed in surveys to date, so only Pt Hope Offshore (ERA 107) has been identified for them. The percent of trajectories contacting ERA 107 is 1-4% within 60 or 360 days in summer, and 1-1% with 360 days in winter.

Humpback Whale (Endangered)

Summer Spill. Humpback whales are present only during the open-water season and could mostly be affected by VLOS during this season. They occur in very low numbers and are widely distributed along the U.S. Chukchi Sea with greater abundances occurring south of Cape Lisburne and in Russian waters. The observation and data records regarding humpback whales observed in the Leased Area and adjacent waters indicate so few occur, only Pt Hope Offshore (ERA 107) and Bering Strait (BS 2) have been identified as important humpback whale resource areas. The percentage of trajectories contacting ERA 107 and BS 2 are analyzed below for a summer VLOS, and best represent humpback habitat use at this time. The percent of trajectories contacting ERA 107 is 1-4% within 60 or 360 days in summer, and .0.5% with 360 days in winter. The percent of trajectories contacting BS 2 is 1-1% within 60 or 360 days in summer, and 1-1% within 360 days in winter.

Gray Whale

Summer Spill. The OSRA model results, unless otherwise noted, are expressed as percent of spill trajectories contacting within 60 and 360 days during summer, and 360 days during winter (Table 4-67). Gray whales are present in the Chukchi and Beaufort Seas during the open-water season and vulnerable to a summer VLOS. ERAs 61, 82, 83, 108, 120, and 121 represent consistent annual feeding and aggregation areas gray whales use during the summer and fall period (Ljungblad et al., 1988; Clark et al., 2014; Clarke et al., 2013). Historically shoal areas such as Hanna Shoal Area (ERA 56) were used by feeding gray whales, and industry observations (Funk et al., 2010 and 2011) indicate the summer presence of gray whales east and south of Hanna Shoal, near the Leased Area. Gray whales that summer in the eastern Chukchi Sea migrate south along the coast during late summer and fall, and could contact spilled oil in ERAs 61, 107, and 108.

Table 4-67. Gray Whales-Summer or Winter Fraction of VLOS Contacting a Certain ERA.[1]

Season / Analysis Period	% Range to ERAs ≥0.5%	ERA IDs with any value ≥0.5%
Summer 60 days	1-11	49, 53, 54
	8-33	56
	16-54	61
	1-10	82, 83
	1-6	107, 108
	2-9	120
	1-8	121
Summer 360 days	1-11	49, 53, 54
	8-35	56
	17-55	61
	2-10	82, 83
	1-6	107, 108
	3-10	120
	1-8	121
Winter 360 days	1-17	49, 53, 54
	1-2	56
	1-3	61
	1-1	121
Name of ERAs Contacted ERA1 Kasegaluk Lagoon Area;ERA20 East Chukchi Sea Offshore; ERA30 Beaufort Spring Lead 1; ERA31 Beaufort Spring Lead 2; ERA 49 Chukchi Sea Spring Lead 1; ERA 53 Chukchi Sea Spring Lead 2; ERA54 Chukchi Sea Spring Lead 3; ERA110-119 AK BFT Outer Shelf and Slope 1 -10.		

Notes: [1] Fraction of a VLOS (expressed as a percent of trajectories) Contacting a Certain ERA within 60 or 360 days during Summer or Winter from any LA.

Appendix A, Tables A.1-11, A.2-28, 30, and 54, Maps A-2a through 2f, LA= Launch Area, ERA = Environmental Resource Area.

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. Observation data indicate minke whales are uncommon in the Leased Area. No aggregation or important feeding areas are identifiable; however, ASAMM observations (Clarke et al., 2014) indicate they are sometimes observed in nearshore Chukchi Sea waters along the Alaskan coastline. The Chukchi Sea summer spill discussion noted above for humpback whales and gray whale nearshore ERAs may best represent the minke whale use areas that could be contacted by a VLOS.

Beluga Whale

Summer Spill. The OSRA model results, unless otherwise noted, are expressed as percent of spill trajectories contacting within 60 and 360 days during summer, and 360 days during winter (Table 4-68). 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 (ERA 1) each summer to molt. If a VLOS did contact the shoreline, oil could persist up to more than a decade in the sediments (Appendix A, Table A.1-3).

Winter Spill. Beluga whales would also be vulnerable to oil contact during the spring migration (April through June) throughout the Beaufort and Chukchi Sea spring lead system (ERAs 30, 31, 49, 53 and 54). Direct contact with some spilled oil could occur portions of the spring lead system were contaminated with oil slick.

Table 4-68. Beluga Whales- Summer or Winter Fraction of VLOS Contacting a Certain ERA.[1]

Season / Analysis Period	% Range to ERAs ≥0.5%	ERA IDs with any value ≥0.5%
Summer 60 days	1-9	1
	1-2	20, 30, 31
	1-11	49, 53, 54
	1-15	110-119
Summer 360 days	1-9	1
	1-2	20, 30, 31
	1-11	49, 53, 54
	1-12	110-119
Winter 360 days	1-3	20, 30, 31
	1-17	49, 53, 54
	1-3	110-119
Name of ERAs Contacted ERA1 Kasegaluk Lagoon Area;ERA20 East Chukchi Sea Offshore; ERA30 Beaufort Spring Lead 1; ERA31 Beaufort Spring Lead 2; ERA 49 Chukchi Sea Spring Lead 1; ERA 53 Chukchi Sea Spring Lead 2; ERA54 Chukchi Sea Spring Lead 3; ERA110-119 AK BFT Outer Shelf and Slope 1 -10.		

Notes: Fraction of a VLOS (expressed as a percent of trajectories) Contacting a Certain ERA within 60 or 360 days during Summer or Winter from any LA.

Appendix A, Tables A.1-11, A.2-28, 30, and 54, Maps A-2a, 2b, 2e, 2f , LA= Launch Area, ERA = Environmental Resource Area.

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 for killer whales in the Chukchi Sea indicates so few occur in the Chukchi Sea that important habitats cannot be 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 Sea coast and the Arctic lagoons (Elson Lagoon, Kugrua Lagoon) and along the coast between Wainwright and Barrow and (Suydam and George, 1992; Roseneau, 2010). Observation data for harbor porpoise in the Chukchi Sea indicates so few occur there that habitats cannot be 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.

4.5.7.1.7. Conclusion

Direct contact with spilled oil resulting from a VLOS would have the greatest potential to 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 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 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 mi (96.5 km) Corridor I Deferral illustrated in Figure 1-1. 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 mi (96.5 km) 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 mi (48 km) deferral area known as the Corridor II Deferral. Corridor 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 (Endangered)

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 km 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, cleanup, remediation and recovery are not expected to result in population level effects.

Fin Whale (Endangered)

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 (Endangered)

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 Sea 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 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 and 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 dependent 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 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 cleanup 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.

4.5.7.2. Ice Seals

A VLOS is hypothesized to occur following a series of operational failures in a scenario described in Section 4.4.2. 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 Cleanup (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 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. 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 localized areas, since spotted seals select only a few locations along the Chukchi and Beaufort Sea 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.

4.5.7.2.1. 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 Leased 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 analyzed 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 (197 ft) from a drilling unit. Based on density estimates produced by NMFS (Allen and Angliss, 2013; Cameron et al., 2009; Kelly et al., 2010) and marine mammal surveys (Funk et al., 2010; Blees et al., 2010; Brueggeman et al., 1992, 2010), only a few seals, likely less than five, could reasonably be expected to be affected by a large explosion anywhere in the Leased Area (based on density estimates described in Kelly et al., 2010 and Cameron et al., 2010). Any resulting losses in the local seal populations could not lead to population level effects.

Fire. Fire from an initial 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 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 the 2011 SEIS (Section IV.E.4). Because marine worms, echinoderms, and mollusks 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 macro-faunal 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, Parris, and Nichols, 2010 and Blanchard, Nichols and Parris, 2010). Other species of ice seals whose diets do not depend on benthic species would not likely be affected by sediment redistribution.

4.5.7.2.2. Phase 2 (Offshore Oil)

Ice seals would be exposed to hydrocarbons in offshore areas during a hypothetical VLOS event. Oil in the Chukchi Sea could cause short-term physiological effects to ice seals, could affect their prey resources, and could cause mortalities of some seals. Additional information about potential impacts of crude oil on seals is available in the 2007 FEIS (Section IV.C.1.h(4)) and here in Section 4.3.7.

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; however, other aggregation areas include sections of the Chukotka coastline, particularly near Kolyuchin Bay and coastal areas to the south. During the 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 of the southern Chukchi Sea, away from the coast and areas of sea ice. 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, using breathing holes, or lead systems and polynyas to access water. During winter and spring ringed seals prefer areas of landfast ice, while bearded seals utilize leads and polynyas, and generally avoid landfast 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 1976a, 1976b; 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). Lowry, Frost, and Pitcher (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 2007 FEIS (Section IV.C.1.h(4)), 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 the 2011 SEIS (Sections IV.E.5 and 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 euphausiids 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 two 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 mollusks 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.

4.5.7.2.3. 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 Section 4.5.7.1.2, Phase 2, and in the 2007 FEIS (page IV-156).

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 sediment 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 affect foraging success for spotted seal species. Such effects might last across seasons and perhaps a few years.

4.5.7.2.4. 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, 2009a, 2010; Funk et al., 2010; Treacy, 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 would 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 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 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 many severe impacts.

4.5.7.2.5. Phase 5 (Long-term Recovery)

Long-term is defined as affecting populations for more than two years. The possible loss of several thousand spotted, bearded, and ringed seals could continue for two years and potential recovery may enter the long-term phase. The recent listing of ringed and bearded 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 effects to seal populations. Such effects would depend on the severity of climate induced population declines, available habitat, predation, habitat quality, etc., and are merely speculative.

4.5.7.2.6. Oil-spill Trajectory Analysis

A VLOS could contact offshore and nearshore areas where seals may be present. The percent of trajectories contacting depends on the location, timing, and magnitude of the spill. The OSRA model uses 6 launch areas (LAs) to model the origin of spill trajectories. The LAs are found in Appendix A, Map A-5.

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, BOEM has determined from 39 to 74 days would be required for another drill vessel to transit to the site and drill a relief well.

A VLOS would be widely distributed and patchy, which may allow some seals to at least partially avoid or reduce contact with the oil slick, reducing the overall effects on some individuals.

A VLOS 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, BOEM 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, BOEM has also analyzed a period of 360 days.

This section describes the results estimated by the OSRA model of a hypothetical VLOS in the Chukchi Sea contacting specific 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 landfast 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 and GLSs ice seal concentrations are shown in Appendix A, Table A.1-14, and the likelihood of any species being affected by a VLOS would 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 (100s and 1,000s) may be found in Kasegaluk lagoon, Avak Inlet, and between Kotzebue and Wales on the Seward Peninsula coast, while lower concentrations (10s) occur in Admiralty, Smith, Kugrua and Peard Bays; and the Colville River Delta during summer.

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 would 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 that trajectories from LAs could contact ERAs or GLSs important to ice seals. The OSRA model results, unless otherwise noted, are expressed as percent of trajectories contacting within 60 and 360 days during summer, and 360 days during winter (Table 4-69).

Table 4-69. Ice Seals–Summer or Winter Fraction of VLOS Contacting a Certain ERA or GLS.[1]

Season / Analysis Period	% Range to ERAs ≥0.5%	ERA IDs with any value ≥0.5%
Summer 60 days	1-9	1
	5-24	6
	1-2	30, 31
	1-1	46
	1-11	49, 53, 54
	6-21	64
Summer 360 days	1-9	1
	5-24	6
	1-2	30, 31, 46
	1-1	48
	1-11	49, 53, 54
	6-21	64
Winter 360 days	4-20	6
	1-3	30, 31, 64
	4-15	46
	5-36	48
	10-21	62
Season / Analysis Period	**% Range to GLSs ≥0.5%**	**GLS IDs with any value ≥0.5%**
Summer 60 days	1-4	135
Summer 360 days	2-5	135
Winter 360 days	1-1	135
Name of ERAs Contacted: ERA1 Kasegaluk Lagoon Area; ERA6 Hanna Shoal; ERA46 Wrangel Island 12 nmi (14 mi or 22 km) Buffer 2; ERA48 Chukchi Sea Lead System 4; ERA62 Herald Shoal Polynya 2; ERA64 Peard Bay Area; Name of GLSs Contacted: GLS135 Kolyuchin Bay; GLS153 Smith Bay Spotted Seal Haulout		

Notes: [1] Ice Seals–Fraction of a VLOS (expressed as a percent of trajectories) Contacting an ERAs or GLSs Within 60 or 360 Days During Summer or Winter from any LA.

Appendix A, Table A.1-14, Tables A.2-28, 30, 40, 42, 54, 60, Maps A-2a,2c, 2f, A-4b, 4c LA= Launch Area, ERA = Environmental Resource Area, GLS = Grouped Land Segment

4.5.7.2.7. 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 areas of the Chukchi Sea. Since they forage for benthic species, bearded seals must associate with continental shelf waters, and so their population densities tend to be higher in the southern Chukchi Sea early in the spring, and remain highest in the ice front as sea ice retreats during the open-water season. 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 numbers of bearded seals in the Beaufort. Consequently, in some years bearded seals in the Beaufort Sea may forage farther from the ice front than those in the Chukchi Sea. The number 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.

Grouped 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 can access water and food resources. During the summer bearded seals do not aggregate, spending much of their time foraging at sea. Throughout the year bearded seals avoid nearshore areas including areas of landfast ice. The ERAs for seals were described in Appendix A, Table A.1-14. The OSRA model results, unless otherwise noted, are expressed as percent of trajectories contacting within 60 and 360 days during summer, and 360 days during winter (Table 4-69).

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 lucrative hunting areas from the perspective of a benthos-feeding bearded seal. Consequently, one may expect somewhat larger densities of bearded seals in the vicinity of Hanna Shoal (ERA 6), and LAs had a 5-24% of trajectories contacting Hanna Shoal (ERA 6) within 60 days. However, any spills in the open water could very likely affect some bearded seals since they are somewhat ubiquitous in the northern Chukchi and Beaufort Seas.

Summer within 360 Days. The OSRA model estimates Hanna Shoal (ERA 6) has a 5-25% of trajectories contacting from all LAs within 360 days.

Winter within 360 Days. A VLOS event from the LAs could also contact spring lead systems, the shear zone around Wrangel Island, Russia, and polynya systems. Spring lead systems in the Beaufort Sea include Beaufort Spring Lead 1 (ERA 30), and Beaufort Spring Lead 2 (ERA 31), which have a 1-3% of trajectories contacting within 360 days from a winter VLOS. Lead systems in the Chukchi Sea that have a >0.5% of trajectories contacting contact include the Chukchi Sea Lead System 4 (ERA 48) which has a 5-36% of trajectories contacting from a winter VLOS. The leads produced by the shear zone surrounding Wrangel Island 12 nmi (14 mi or 22 km) Buffer 2 (ERA 46) have a 6-15% of trajectories contacting from a winter spill within 360 days.

Polynya systems that could be contacted by a VLOS occur at Hanna Shoal (ERA 6), and Herald Shoal Polynya 2 (ERA 62), which have 4-20%, and a 10-21% of trajectories contacting within 360 days from a winter VLOS respectively, other ERAs have <0.5% of trajectories contacting from all LAs.

4.5.7.2.8. Ringed Seals (Threatened)

As with bearded seals, ringed seals have a strong association with sea ice. However, unlike bearded seals, ringed seals prefer to overwinter in landfast ice, particularly where heaves and irregularities create icy hummocks that can protect their lairs from polar bears. 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, no GLS, ERA or BS was identifiable for ringed seals; however, they do concentrate in polynyas and lead systems if those features are available. Polynya and lead systems are analyzed for the 60 or 360 days summer, or 360 day winter time periods. The ERAs for ringed seals were described in Appendix A, Table A.1-14, as was a single GLS was identified for ringed seals at Kolyuchin Bay (ERA 104). The OSRA model results, unless otherwise noted, are expressed as percent of trajectories contacting within 60 and 360 days during summer, and 360 days during winter (Table 4-69).

Summer within 60 Days. The 60 day summer VLOS analysis for ringed seals is similar to what is analyzed for bearded seals. In addition to chance of contact with ERAs 30 and 31 (1-3% of trajectories contacting), ERAs 49 and 53 (1-9% of trajectories contacting), ERA 46 (1% of trajectories contacting), and ERA 62 (<0.5% of trajectories contacting); Kotzebue Sound (ERA 104) and Kolyuchin Bay (GLS 135) were identified as important areas for ringed seals based on existing information (ADF&G, 2001; Boveng et al., 2009; Kelly et al., 2010; Heptner et al., 1996). Within 60 days Kotzebue Sound (ERA 104) has a <0.5% of trajectories contacting and GLS 135 had 1-4% of trajectories contacting from all LAs (Table A.2-28; A.2-40).

A large number of ringed seals would likely be within foraging distance from the ice front during the open-water season; however, the ebbs and flows of the ice front make assigning a fixed area to the ice front impractical.

Summer within 360 Days. The ERAs 30, 31, and 46 have a 1-2% of trajectories contacting, and ERAs 48,49, and 53-54 have a 1-11% of trajectories contacting from LAs at 360 days. GLS 135 has a

2-5% of trajectories contacting from LAs, and ERAs 62 and 104 have <0.5% of trajectories contacting within 360 days (Table A.2-30).

Winter within 360 Days. A winter VLOS contacting the Hanna Shoal (ERA 6) polynya system would have a 4-20% of trajectories contacting from All LAs within 360 days. Likewise, a winter VLOS within 360 days would have a 10-21% of trajectories contacting Herald Shoal Polynya (ERA 62) from all LAs. The percent of trajectories contacting lead systems would be 1-3% for ERAs 30 and 31 from LAs 5 6, 10, and 11; 1-27% for ERAs 53 and 54 from LAs 4, 5, 6, 10, and 11; and 5-36% for ERAs 48 from all LAs, and a 1-7% of trajectories contacting ERA 49 from LAs 4, 5, 6, 10, and 11 within 360 days (Table A.2-54).

A VLOS would also have a 4-15% of trajectories contacting ERA 46 from all LSs within 360 days. Lastly, GLS 135 would have a 1% of trajectories contacting from LA 10 within 360 days. All other ERAs have <0.5% of trajectories contacting and will not be analyzed further.

4.5.7.2.9. Ribbon Seals

Very low numbers of ribbon seals have been detected during marine mammal surveys in the Chukchi Sea (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, relying on sea ice to whelp and molt, then returning to the water for the remainder of the year. Most ribbon seals are found in the southern and western regions of the Chukchi Sea, and are sometimes observed in the eastern and east-central Chukchi Sea, and rarely a ribbon seal is observed in the vicinity of Barrow, Alaska. Whelping occurs in the Bering Sea, and perhaps in a few areas of the southern Chukchi Sea, and so there should be little risk to ribbon seals from the Proposed Action. Any ribbon seals that could be affected by a VLOS would be in the open water, in very low densities.

Limited observations of ribbon seals in the Chukchi Sea preclude the designation of ERAs, GLSs, LSs, or BSs for ribbon seals. At most, no more than a few tens to a few hundred ribbon seals could be affected by a VLOS from LAs in the Leased Area. If a VLOS occurred, a fraction of the ribbon seals could be killed, while the remainder would likely recover within a few days. Such numbers would not affect ribbon seal stock in U.S. waters, though recovery could last up to three years, depending upon the number of individuals affected.

4.5.7.2.10. 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, areas around Kotzebue Sound, and some areas along the Chukotka coast, particularly Kolyuchin Bay. The number of seals using haulout sites in the Beaufort Sea are small by comparison to some Chukchi Sea haulouts, which support thousands of spotted seals. Verified spotted seal haulouts in the Beaufort Sea include Dease Inlet/Admiralty Bay, Smith Bay, and Oarlock Island in the eastern Colville River Delta. Haulouts occurred at one time in the Sagavanirktok River Delta with possible haulouts east to Camden Bay, Alaska. None of those locations have been verified active in recent decades and so are assumed to be defunct. 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, and most use nearshore and coastal habitat.

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 10s of seals in the Beaufort Sea. The largest aggregation of spotted seals that could be oiled occurs in Kasegaluk Lagoon (ERA 1) between Icy Cape and Wainwright, SUA: Shishmaref, North (ERA 5), and Kotzebue Sound (ERA 104) where thousands of spotted seals haul out during summer. Kolyuchin Bay (GLS 135), Russia is another location where large numbers of spotted seals are believed to haulout, and many spotted seals are known to feed in Peard Bay/Franklin Spit (ERA64). The OSRA model results, unless otherwise noted, are expressed as percent of trajectories contacting within 60 and 360 days during summer, and 360 days during winter (Table 4-69).

Summer within 60 Days. ERA 1 has a 1-9% of trajectories contacting, and ERA 64 has a 6-21% chance of contact from all LAs within 60 days (Table 4-69). GLS 135 has a lower percent of trajectories contacting (1-4%) from all LAs within 60 days. All other ERAs and GLSs have <0.5% of trajectories contacting from any LAs within 60 days.

Summer within 360 Days. Within 360 days the percent of trajectories contacting is1-9% for ERA 1, and 6-21% for ERA 64. Within 360 days the percent of trajectories contacting GLS 135 is to 2-5%. All other ERAs, or GLSs, have percent of trajectories contacting <0.5% and will not be analyzed further.

Winter within 360 Days. The OSRA estimates GLS 135 has a 1% percent of trajectories contact from LA 10, and ERA 64 has a 1-3% percent of trajectories contacting from LAs 4,5,10, and 11 within 360 days (Table 4-69). All other ERAs have <0.5% of trajectories contacting, and will not be analyzed further.

4.5.7.2.11. Conclusion

In the event of a VLOS, ice seals could be affected to varying degrees depending on distribution, activity, number affected, 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, Peard Bay/Franklin Spit, 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 others combined. Though spotted seals forage for fishes in nearshore areas, their presence is not known to be strongly correlated with pelagic areas and the ice front during summer. 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 the very low numbers of ribbon seals documented in biological surveys of the Chukchi Sea, they are assumed to occur in very low numbers, and to be widely distributed across the northern Chukchi Sea, absent from the Beaufort Sea, and mostly concentrated in the southern Chukchi Sea and in the Bering Sea during summer. Because of their scarcity in and around the Leased Area and northern Chukchi Sea the ribbon seal population, and stock, should remain unaffected by a VLOS from any of the LAs.

Both bearded and ringed seals closely associate with sea ice throughout the year, and rarely use shore habitat. Both species prefer to remain in proximity to the ice front during summer, though some occur in open waters away from areas of sea ice. Bearded seals feed on benthic organisms on the relatively shallow Chukchi Sea 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 landfast ice. Ringed seals, select landfast ice zones as their preferred habitat where they survive by making and maintaining breathing holes through the ice and by constructing subnivean lairs. A VLOS contacting a polynya or lead systems could consequently have moderate to major effects on ringed and bearded seal populations, potentially oiling or even killing hundreds to thousands of bearded and/or ringed seals. The impacts would be determined by the number of ringed or bearded seals exposed in oiled leads or polynyas. The numbers of seals using an oiled lead system or polynya would likely be a function of the time of year, food resources, and lead or polynya size. For example, if 70,000 adult ringed seals and their pups happened to be using the Chukchi Sea leads during April and those leads became oiled from a VLOS, the effects would likely be major, with many thousands of seals dying from crude oil exposure, especially ringed seal pups.

A contrasting example would be if a VLOS occurred during February when most ringed seals are wintering in the Bering Sea. In this example a few thousand ringed seals would probably be at risk of being contacted with spilled crude oil. While a percentage of those seals would likely die, the numbers of fatalities could not approach what was described in the first example because of the numerical difference of adult seals using the leads, and the fact that female ringed seals have yet to whelp. Seal pups are the demographic group most likely to succumb to oil spills, and their absence from lead systems would reduce the number and proportion of mortalities in the population.

Potential effects of a VLOS event on fishes and invertebrates are analyzed in greater detail in previous sections, and in the SEIS. Because ice seals rely on these organisms for food, any significant impacts on fishes or invertebrates could 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. Displaced seals would compete with seals elsewhere for limited food resources, perhaps lowering the overall fitness of a local population, or even contributing to population losses through malnutrition. Consequently a VLOS has the potential to affect large numbers of ringed, bearded, and spotted seals in part due to the effects their prey and the local food-web, but not that many ribbon seals. Mortality from a hypothetical VLOS could result in temporary population-level effects for bearded, ringed, and spotted seals, but not ribbon seals due to their scarcity in the northern Chukchi Sea. Most of these effects would correct within a generation; however, due to differences in generation times between species, such recoveries could easily take over five years.

4.5.7.3. Pacific Walrus (Candidate species)

A 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 cleanup and well control work. These impacts could include inhalation or exposure to toxic fumes from cleanup products, disturbance at important on ice or terrestrial haulout sites, disturbance at important foraging sites, and destruction of prey species.

The impacts that occur during each phase of a blowout and subsequent cleanup are analyzed 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 (Garlich-Miller, Quakenbush and Bromaghin, 2006) due to changes in sea ice and prey availability (Taylor and Udeitz, 2014). The Pacific walrus is a candidate for listing under the ESA 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, such as decreasing sea ice extent, prey availability or harvest.

4.5.7.3.1. 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 affect 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.

4.5.7.3.2. 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 furbearers 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 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. 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 Oil 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.

4.5.7.3.3. 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.

4.5.7.3.4. Phase 4 (Spill Response and Cleanup Activities)

Spill response and cleanup 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 Alaska Regional Response Team (ARRT) has not pre-approved the use of dispersants in the Arctic, they could be considered on an incident-specific basis. 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 effects by killing prey species and displacing walrus from foraging or resting 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) would become spread out over a larger area. The amount of oil being discharged daily would decrease as the pressure remaining in the well decreases. BOEM has estimated that the flow of oil would decrease from a high of 60,000 bbl/day to just over 20,000 bbl/day over the 74 day spill duration analyzed in this VLOS scenario. The discontinuous area of a VLOS depends upon location of the spill site and the time of the spill. As the spill continues, cleanup 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 would encounter oil and/ or disturbance from cleanup efforts. In recent years, walrus have retreated to coastal haulouts in September due to a lack of sea ice cover as a resting platform (Jay, Fischbach and Kochnev, 2012). Walrus are particularly vulnerable to disturbance events at coastal haulouts, which can result in increased mortality, particularly of calves, with the potential for these mortalities to have population-level effects (Udevitz et al., 2013). 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 cleanup efforts during that season (Jay, Fischbach and Kochnev, 2012; USGS, unpublished tagging data).

Even after the flow of oil has been stopped, responders would continue cleaning any remaining oil that can be located. Cleanup 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 cleanup activities or is an unrelated event (Geraci and St. Aubin, 1990; and Kooyman, Gentry, and McAlister, 1976).

4.5.7.3.5. Phase 5 (Long Term Recovery)

After cleanup efforts have ceased, the remaining oil would 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 would 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.

4.5.7.3.6. Oil-spill Trajectory Analysis

In the 2007 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 (Jay, Fischbach, and Kochnev, 2012). BOEM also has additional information about at sea distribution from tagging studies and surveys. BOEM has incorporated new ERAs since the 2007 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, BOEM has used ERAs and GLSs 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.

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, BOEM has used LSs with a year round vulnerability (Jan-Dec) even though BOEM recognizes 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 would also freeze into the ice where they would 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).

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 Leased Area into 613 launch areas (LAs) to model the spill trajectories from different sources of origin. The LAs are described in Appendix A, Map A-5a. 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. This section describes the results estimated by the Oil-spill Risk Analysis model (OSRA model) of a hypothetical VLOS in the Chukchi Sea contacting specific ERAs, LSs or GLSs where walrus are likely to be found. An ERA is a polygon that represents a geographic area during a specific time period.

The following table (Table 4-70) summarizes the percent of trajectories contacting any of the ERAs, LSs, or GLSs that have been identified as important habitat for walrus. Important walrus habitat areas that are not contacted by <0.5% by trajectories from any of the LAs do not appear in the table. More detailed information can be found in Appendix A, Table A.1-13, and Tables A.2-27 through A.2-66.

Table 4-70. Pacific Walrus Habitat–Summer or Winter Fraction of VLOS Contacting an Area.[1]

Season / Analysis Period	Range to Contact ≥0.5%	ID with any valute ≥0.5%
	% Range to ERAs	**ERA ID**
Summer 60 days	1-4	59, 66
	1-13	11,15, 51, 58
	5-20	52
	3-41	50
	19-76	47
Summer 360 days	1- 4	59, 66
	1-13	11, 15, 51, 58
	6-20	52
	3-41	50
	20-76	47
Winter 360 days	1-5	11, 15, 50, 51, 58, 59, 66
	2-15	47, 52
	% Range to GLSs ≥0.5%	**LS ID**
Summer 60 days	1-1	28, 29
Summer 360 days	1-1	28, 29
Winter 360 days	1-3	28, 29, 38, 39

Season / Analysis Period	Range to Contact ≥0.5%	ID with any valute ≥0.5%
	% Range to LSs ≥0.5%	GLS IDs
Summer 60 days	1-5	136, 138, 145, 147
	2-7	133
	11-21	174
Summer 360 days	1-5	136, 138, 145, 147
	2-8	133
	13-23	174
Winter 360 days	1-5	133, 138, 147,
	14-17	174
	1-5	136, 138, 145, 147
Name of ERAs Contacted: ERA 11-Wrangel Island, ERA 15-Cape Lisburne, ER-47 HSWUA, ERA 50-Point Lay offshore, ERA 51-Point Lay nearshore, ERA 52-Russian coast offshore, ERA 58-Russian coast nearshore, ERA 59-Ostrov Kolyuchin, and ERA 66-Herald Island **Geographic Name of Land Segments Contacted:** LS 28-Vankarem, Vankarem Laguna, LS 29-Mys Onman, Vel'may, LS 38-Enmytagen, Inchoun, Mitkulen, LS 39-Cape Dezhnev, Naukan, Uelen. **Geographic Name of Grouped Land Segments Contacted:** GLS 133-Mys Blossom, GLS 13- Ostrov Ididlya, GLS 138-Chukotka coast haulout,GLS 145-Cape Lisbourne , GLS-147-Point Lay Haulout, GLS-174 Russian Chukchi Sea coastline.		

Notes: [1] Fraction of a VLOS (expressed as a percent of trajectories) Contacting an ERA, LS or GLS Within 60 or 360 Days During Summer or Winter from Any LA.

For ERAs, Appendix A, Tables A.1-13, A.2-28, 30, and 54 Maps A-2a, 2d, 2e , LA= Launch Area, ERA = Environmental Resource Area.

For LSs, Notes: Appendix A, Tables A.1-13, A.2-34, 36, and 54 Map A-3a. LA= Launch Area, LS = Land Segment.

For GLSs, Appendix A, Tables A.1-13, A.2-40, 42, and 66, Maps A-4a, 4b, 4c , LA= Launch Area, GLS = Grouped Land Segment.

4.5.7.3.7. Conclusion

In the event of a VLOS, the OSRA model estimates most of the largest highest percent of trajectories indicating 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 Point Lay. As illustrated in the analysis above, hypothetical spills launched from LAs 6 and 11 exhibit the highest potential for contact with the Hanna Shoal polynyas. 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 Point 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; or if a VLOS contacted a large concentration of walrus at a foraging area such as the HSWUA or while the population is concentrated on sea ice or terrestrial haulouts.

4.5.7.4. Polar Bears (Threatened)

Polar bears are listed under the Endangered Species Act (ESA) as threatened throughout their range. A VLOS could affect polar bears and polar bear 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 cleanup. These impacts could include inhalation or exposure to toxic fumes from cleanup 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 cleanup are analyzed below. The most direct impacts would occur as a result of Phases 2 and 3, which entail an offshore oil spill and onshore contact.

4.5.7.4.1. 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 affect 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; however, polar bears are known to swim long distances between shore and sea ice (Schliebe et al., 2008; Gleason and Rode, 2009, Durner et al., 2011; Pagano et al., 2012).

4.5.7.4.2. 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 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.

4.5.7.4.3. Phase 3 (Onshore Contact)

Depending upon the location of the spill site and other factors, BOEM has estimated that oil could contact shore within 10 days after a VLOS. 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.

4.5.7.4.4. Phase 4 (Spill Response and Cleanup)

Spill response and cleanup 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 Alaska Regional Response Team (ARRT) has not pre-approved the use of dispersants in the Arctic, they could be considered on an incident-specific basis.

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) would become spread out over a larger area. The amount of oil being discharged daily would decrease as the pressure remaining in the well decreases. BOEM has estimated that the flow of oil would decrease from a high of 60,000 bbl/day to a little over 20,000 bbl/day over a 74-day uncontrolled well incident. The discontinuous area of a VLOS depends upon location of the spill site and the time of the spill. As the spill continues, cleanup 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 would encounter oil and/or disturbance from cleanup 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 likely result in mortalities and constitute a significant impact to the SBS or CBS stock of polar bears.

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), therefore, impacts to ringed seal populations would also impact polar bear populations. 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 Point Barrow area), this analysis is focused on the Chukchi and Beaufort Sea spring lead systems, and on nearshore ice in the Beaufort Sea.

The next phase after the VLOS has been stopped would involve cleaning of any remaining oil that can be located. Cleanup 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 icebreakers suggests that bears are likely to move away from icebreaking activities unless they are actively feeding.

The cleanup 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.

4.5.7.4.5. Phase 5 (Long Term Recovery)

After cleanup efforts have ceased, the remaining oil would 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 would occur as a part of the natural resource damage assessment (NRDA) process. 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.

4.5.7.4.6. 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 Leased Area into 6 launch areas (LAs) to model the spill trajectories from different sources of origin. The LAs are found in Appendix A, Map A-5. 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 1 and October 31. The time period for stopping the spill with a relief well ranges from 39 to 74 days. BOEM 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. BOEM, 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 VLOS in the Chukchi Sea contacting specific ERAs, LSs or GLSs where polar bears may be found (Table 4-71). 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 onshore during the open-water season (Schliebe et al., 2007; Regehr et al., 2009; Durner et al., 2009; Amstrup, Marcot, and Douglas, 2008).

Table 4-71. Polar Bear Habitat–Summer or Winter Fraction of VLOS Contacting an Area.[1]

Season / Analysis Period	% Range to ERA, LS, or GLS ≥0.5%	ERA, LS, or GLS with any value ≥0.5%
	ERA	ERA ID
Summer 60 days	1-4	55, 59, 66
	1-14	11, 23
Summer 360 days	1-4	55, 59, 66
	1-14	11, 23
Winter 360 days	1-3	11, 55, 66
	6-71	23

Season / Analysis Period	% Range to ERA, LS, or GLS ≥0.5%	ERA, LS, or GLS with any value ≥0.5%
	LS	**LS ID**
Summer 60 days	2-6	85
Summer 360 days	2-7	85
Winter 360 days	1-2	85
	GLS	**GLS ID**
Summer 60 days	10-21	174
Summer 360 days	13-23	174
Winter 360 days	14-17	174
Name of ERAs Contacted: ERA 11Wrangel Island, ERA 23 offshore Chukchi Sea, ERA 55 Point Barrow, Plover Islands, ERA 59 Ostrov Kolyuchin, and ERA 66 Herald Island. **Name of LSs Contacted:** LS 85 Barrow, Browerville, Elson Lagoon. **Name of GLSs Contacted:** GLS 174 Russian Chukchi Sea coastline.		

Notes: [1] The Fraction of a VLOS (expressed as a percent of trajectories) Contacting an ERA, LS or GLS Within 60 or 360 Days During Summer or Winter from Any Launch Area (LA). ERA = Environmental Resource Area, GLS = Grouped Land Segment. LA= Launch Area, LS = Land Segment.

For ERA, Appendix A, Tables A.1-13, A.2-28, 30, and 54 Maps A-2a, 2b.

For LS, Appendix A, Tables A.1-13, A.2-34, 36, and 54 Maps A-3b.

For GLS, Appendix A, Tables A.1-13, A.2-40, 42, and 66, Map 4c.

An ERA is a polygon that represents a geographic area during a specific time period. The vulnerability of an ERA is based on the seasonal use patterns of polar bears. LS and GLS are sections of the coastline and are not seasonal. For this analysis, BOEM does not consider the effectiveness of cleanup methods. BOEM makes the assumption that if oil contacts the coastline, the oil would remain there. In the event of a VLOS in this scenario, the highest percent of trajectories contacting polar bear habitat would occur along the Russian coastline of the Chukchi Sea or in the southeastern offshore polar bear habitat of the Chukchi Sea. These areas are mostly likely to be contacted by one or more trajectories in part because they are extensive areas.

4.5.7.4.7. Conclusion

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, it could result in the loss of large numbers of polar bears. 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, and Wrangel Island.

4.5.8. Terrestrial Mammals

A VLOS is hypothesized to occur following a series of operational failures. Analysis of the hypothetical VLOS scenario described in Section 4.4.2 is divided into five phases: the Initial Event (Phase 1), Offshore Oil (Phase 2), Onshore Contact (Phase 3), Spill Response and Cleanup (Phase 4), and Long Term Recovery (Phase 5). These phases and the types of impacts that could occur during each are analyzed 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, particularly in the vicinity of Cape Lisburne and Kasegaluk Lagoon. 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.

4.5.8.1. 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 would disperse into the atmosphere around a drilling rig.

4.5.8.2. 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; Wolcow, 2005). Arctic foxes range far over the landfast 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 the 2007 FEIS (Section IV.C.1.i(4)(d)), 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 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, several grizzly bears could be affected. 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.

4.5.8.3. 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 the 2007 FEIS (Section IV.C.1.i (4)(d)), 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 the 2011 SEIS (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.

4.5.8.3.1. Contact with Oil

The effects of terrestrial mammals contacting crude oil were described in Phase 2, and the 2007 FEIS (page IV-176), and in Section 4.3.8.

4.5.8.3.2. 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. The 2007 FEIS (Section IV.C.1.i(4)(d)) analyzes and summarizes the effects of an oil spill on terrestrial mammals in greater detail.

4.5.8.3.3. 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.

4.5.8.3.4. 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 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.

4.5.8.4. 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 2007 FEIS (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 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.).

4.5.8.5. Phase 5 (Long-term Recovery)

Long-term is defined as an effect that continues in populations for more than two 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 (Krümmel 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.

4.5.8.6. Oil-spill Trajectory Analysis

Terrestrial mammals may experience physiological effects from exposure to an oil spill through oiling of their fur, and ingesting oiled food items. Grizzlies, furbearers, caribou, and muskoxen would only be affected at very specific Grouped Land Segments (GLSs) during the summer, open-water season or by consuming oiled food items in the coastal zone in the event of a spill. 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.

A very large spill could contact offshore and nearshore areas terrestrial mammals may frequent. The percentage of trajectories contacting the resource would depend on the location, timing, and magnitude of the spill, ocean currents, weathering, and other factors. The OSRA model uses 6 launch areas (LAs) to model the origination of spill trajectories. The LAs are described in Appendix A, Map A-5. 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, BOEM 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 with the Exxon Valdez Oil-spill incident in Prince William Sound, Alaska. Instead they flow into the ocean at rates that decrease over time. For the briefest spill period, BOEM 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, BOEM 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 BSEE.

This section describes the results estimated by the OSRA model of a hypothetical VLOS in the Chukchi Sea contacting specific GLSs 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 would have weathered away.

The OSRA model estimates that trajectories from LAs could contact GLSs important to terrestrial mammals. The OSRA model results, unless otherwise noted, are expressed as percent of spill trajectories contacting within 60 and 360 days during summer, and 360 days during winter. 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 day summer and 360-day summer and winter time periods. To focus on significant impacts (or elevated potential for significant impacts), only percentages of trajectories ≥ 5% are analyzed.

4.5.8.7. 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 ice 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 across the Brooks Range and into Canada. The primary land segments where insect relief most frequently occurs include GLS 143 (WAH Insect Relief), 152 (TCH Insect Relief/Calving), 156 (CAH Insect Relief/Calving), 162 (PCH Insect Relief), 152 (TCH Insect Relief/Calving), and 173 (Tuktoyaktuk and Cape Bathurst Caribou Insect Relief). GLS 1632 (PCH Calving) represents the coastal calving area for the PCH in the 1002 Area of the Arctic National Wildlife Refuge and the Village of Kaktovik, Alaska.

A VLOS remaining in the offshore area should have no identifiable effects on caribou. For the onshore contact phase, none of the GLSs identified as insect relief areas or calving areas have ≥5% trajectories contacting within 60 and 360 days summer or winter (Table 4-72).

Table 4-72. Caribou - Summer or Winter Fraction of VLOS Contacting a Certain GLS.

Season / Analysis Period	% Range to GLSs ≥0.5%	GLS IDs with any value ≥0.5%
Summer 60 days	1-4	143, 152
Summer 360 days	1-4	143, 152
Winter 360 days	1	143
Name of Grouped Land Segments Contacted: GLS143 WAH Insect Relief; GLS 152 TCH Insect Relief/Calving		

Notes: Fraction of a VLOS (expressed as a percent of trajectories) Contacting a Certain GLS Within 60 or 360 Days During Summer or Winter From Any LA.

Appendix A, Tables A.1-17, A.2-40, 42, 66, Maps A-4b, 4c, LA= Launch Area, GLS = Grouped Land Segment, ID=Identification Number. Percent Trajectories contacting GLS156, 162, 163, 168 or 173 <0.5% within 60 or 360 days summer or winter.

4.5.8.8. 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. GLSs that have been identified as important coastal habitat areas for muskox include GLSs 158 (Beaufort Muskox) and 164 (Yukon Muskox Wintering).

A VLOS remaining in the offshore area should have no identifiable effects on muskox. For the onshore contact phase none of the GLSs identified important to muskox have ≥5% trajectories contacting within 60 and 360 days summer or winter.

4.5.8.9. 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 GLS 146 (Ledyard Brown Bears), GLS 148 (Kasegaluk Brown Bears). 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 landfast 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 bear population. For the onshore contact phase none of the GLSs identified important to grizzlies have ≥5% trajectories contacting within 60 and 360 days summer, except for LA 10 which has 6% of trajectories contacting GLS 148 (Table 4-73).

Table 4-73. Grizzly Bear - Summer or Winter Fraction of a VLOS ontacting a Certain GLS.[1]

Season / Analysis Period	% Range to GLSs ≥0.5%	GLS IDs with any value ≥0.5%
Summer 60 days	1-6	146,148
Summer 360 days	1-6	146,148
Winter 360 days	1	146,148
Name of Grouped Land Segments Contacted: GLS146 Ledyard Brown Bears; GLS 148 Kasegaluk Brown Bears.		

Notes: [1] Fraction of a VLOS (expressed as a percent of trajectories) Contacting a Certain GLS Within 60 or 360 Days During Summer or Winter from any LA.

Appendix A, Tables A.1-17, A.2-40, 42, 66, Maps A-4b, LA= Launch Area, GLS = Grouped Land Segment, ID=Identification Number.

Winter within 360 Days. During winter within 360 days no GLSs have >5% trajectories contacting.

4.5.8.10. 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 landfast and pack ice to scavenge and sometimes hunt. 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 unlikely to come into contact with a VLOS at any time of the year, particularly in numbers resulting in population level effects, since they live solitary lives. 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 LSs, and include the 60-day time period for a VLOS. It would be pointless to analyze ERAs 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 VLOS remaining in the offshore area should have no identifiable effects on furbearers.

4.5.8.11. 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.

4.5.9. 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 (Section 3.1.3) and moderate winds of the region that average 12 miles per hour (Section 3.1.2), creating a low potential for spilled oil to reach beyond the intertidal area. The shoreline is characterized by nearly continuous sea cliffs up to 12m high, some with cliffs abutted by narrow beaches (Section 3.1.3). 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.

4.5.9.1. Phase 1 (Initial Event)

There are no potential impacts to vegetation and wetlands from the initial blowout event.

4.5.9.2. Phase 2 (Offshore Oil)

Oil from offshore areas would not contact vegetation and wetlands. Vegetation and wetlands are not potentially impacted during Phase 2.

4.5.9.3. 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 (Prince, 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 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 (Wang, Liu, and Jin, 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; McKendrick, 2000; NOAA, 1994; Pezeshki 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 (McKendrick, 2000; USDOI, BLM, 2012; USDOI, 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 et al., 2008).

4.5.9.4. Phase 4 (Spill Response and Cleanup)

Spill cleanup operations might 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.

4.5.9.5. Phase 5 (Long-term Recovery)

Long-term is defined as an effect that affects populations for more than two 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).

4.5.9.6. 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 VLOS 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 six launch areas (LAs) to model the origination of spill trajectories (Appendix A, Map A-5). 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, BOEM has determined from 39 to 74 days would be required for another MODU 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 BOEM 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 BOEM has also analyzed a spill window of 360 days. A VLOS continuing after October 31 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 15 shorelines types (Table A.1-3): 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 Alaska's 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.1-3 and 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 LS.

Environmental Sensitivity Indexes have not been delineated for Far Eastern Russia's shoreline closest to the Chukchi Sea, includes the coasts of Wrangel Island and Chukotka Peninsula. Therefore, it is not possible to apply the OSRA model estimates for sheltered vegetated low banks and salt/brackish water marshes of the coastal area for LS in Far East Russia.

4.5.9.7. Sheltered Vegetated Low Banks

For summer or winter spills that may contact U.S. coastline of Alaska's North Slope, the OSRA model estimates that within 60 or 360 days (Table 4-74), 1% to 4% percent of trajectories from all LAs would contact LS64-66 and LS71-84. In addition LS85 ranges up to 7%. Of these LSs, some have 5% or more sheltered vegetated low banks (Table A.1-3 column 9B) and include: LS64; Kuchaurak and Kuchiak Creek (21%) LS70; Tungaich Point, Tungak Creek (5%) LS73; Akeonik, Icy Cape (11%) LS75; Avak Inlet, Tunalik River (8%) LS76; Nivat Point, Point Collie, Sigeakruk (7%) LS78; Will Rogers and Wiley Post Memorial (8%) LS84.

Table 4-74. U.S. Alaska – Summer or Winter Fraction of VLOS Contacting a certain LS.

Season / Analysis Period	% Range to LSs ≥0.5%	LS IDs with any value ≥0.5%
Summer 60 days	1-4 except LS85 2-6	64-66, 71-85
Summer 360 days	1-4 except LS85 2-7	64-66, 71-85
Winter 360 days	1-2	64-66, 74-76, 83-85
Geographic Name of Land Segments Contacted in Alaska: LS64 Aiautak Lagoon, Ipiutak Lagoon, Kowtuk Point, Kukpuk River, Pingu Bluff, Point Hope, Sinigrok Point, Sinuk; LS65 Buckland, Cape Dyer, Cape Lewis, Cape Lisburne; LS66 Ayugatak Lagoon; LS71 Kukpowruk River, Naokok, Naokok Pass, Sitkok Point; LS72 Epizetka River, Kokolik River, Point Lay, Siksrikpak Point; LS73 Akunik Pass, Tungaich Point, Tungak Creek; LS74 Kasegaluk Lagoon, Solivik Island, Utukok River; LS75 Akeonik, Icy Cape, Icy Cape Pass; LS76 Akoliakatat Pass, Avak Inlet, Tunalik River; LS77 Mitliktavik, Nivat Point, Nokotlek Point, Ongorakvik River; LS78 Kilmantavi, Kuk River, Point Collie, Sigeakruk Point; LS79 Point Belcher, Wainwright, Wainwright Inlet; LS80 Eluksingiak Point, Igklo River, Kugrua Bay; LS81 Peard Bay, Point Franklin, Seahorse Islands, Tachinisok Inlet: LS82 Skull Cliff: LS83 Nulavik, Loran Radio Station: LS84 Walakpa River, Will Rogers and Wiley Post Memorial; LS85 Barrow, Browerville, Elson Lagoon		

Notes: Fraction of a VLOS (expressed as a percent of trajectories) contacting a certain LS within 60 or 360 days during summer or winter from any LA.

Appendix A, Tables A.2-34, 36, 60, Map A-3b, LA= Launch Area, LS = Land Segment

4.5.9.8. Salt/Brackish Water Marshes

For summer or winter spills that may contact U.S. coastline of Alaska's North Slope, the OSRA model estimates that within 60 or 360 days (Table 4-74), 1% to 4% percent of trajectories from all LAs would contact LS64-66 and LS71-84. In addition LS85 ranges up to 7%. Of those LSs which a percent chance of trajectories contacting some have 5% or more salt/brackish water marshes (Table A.1-3 column 10A) and include: LS66; Cape Sabine, Pitmegea (19%) LS67; Point Lay (5%) LS72; Tungaich Point, Tungak Creek (10%) LS73; Kasegaluk Lagoon, Solivik Island (5%) LS74; Akeonik, Icy Cape (5%) LS75.

4.5.9.9. 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 cleanup 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 Leased Area, could reduce the chance of a VLOs from contaminating nearshore, estuarine, intertidal, and riverine waters. Since the larger deferral associated with Alternative III would reduce the number of leases (5) that are nearest to the coast, Alternative III has greater potential to reduce onshore and nearshore impacts as compared with Alternative IV.

4.5.10. Economy

This discussion of employment for oil-spill response is based on the most relevant historical experience of a spill in Alaskan waters, the EVOS spill of 240,000 bbl in 1989. It generated 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 to 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. Additional housing and infrastructure may 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 cleanup efforts. BOEM assumes that any additional infrastructure built onshore would also be an enclave.

In the event of a 2,160,200 bbl 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 VLOS of 2,160,200 bbl 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. BOEM expects employment of cleanup workers to increase rapidly during Phase 2 and Phase 3, and peak during Phase 4. The number of workers would likely be much larger than the number of workers who cleaned up the EVOS. For assumptions of spill sizes, see Section 4.4.2. 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 land and waters.

The number of vessels and responders would increase exponentially as the spill continued, peaking in Phase 4. See Section 4.4.2 for 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 4.4.2. BOEM assumes 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 VLOS would be in the form of property tax revenues from any new infrastructure built to house the influx of workers and infrastructure. If TAPS throughput is reduced because of the oil spill, either through a temporary moratoria on oil and gas activities or space-use conflicts with producing fields, direct revenues accruing to the State would be 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 effect on Alaska economic output as delivery of goods and services could be reduced.

4.5.10.1. Impacts to Potential Future Economic Activity

A hypothetical VLOS 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 impacts on jobs and revenues generated by potential tourism and marine shipping in the region.

A hypothetical VLOS would also result in a Natural Resource Damage Assessment (NRDA). The National Ocean and Atmospheric Administration (NOAA) conducts NRDAs 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. The result of the NRDA process could have substantial revenue impacts as the population of interest is compensated for a range of natural resource service values damaged by the hypothetical VLOS and come at a high cost to the responsible parties.

Effects of a VLOS on the economy are analyzed below for each of the five phases of the hypothetical scenario.

4.5.10.2. 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 would be mobilized and sent to the site of explosion to address a fire. Employment and personal income levels would be moderate during this initial phase.

4.5.10.3. Phase 2 (Offshore Oil)

In Phase 2, the relevant impact producing factors for the economy include contact with oil, contamination, and loss of access. 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 continue to mobilize and first responders begin 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. In Phase 2, there could be increasing space/use conflicts for access to and use of shipping lanes, open water space, and dock/port space.

4.5.10.4. 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.

4.5.10.5. Phase 4 (Spill Response and Cleanup)

Potential impact producing factors in Phase 4 that would 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 would 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.

4.5.10.6. Phase 5 (Post Spill, 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 would begin declining from peak levels.

4.5.10.7. Potential for Oil to Contact Resource

Potential impacts to the economy during each phase of the hypothetical scenario are addressed above. In terms of oil-spill impacts, the conditional probability analysis for economic impacts is not expected to be different for a hypothetical spill regardless of which launch area it emanates from or the conditional probability that a particular environmental resource area is contacted by oil. 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.

4.5.10.8. Conclusion

A hypothetical VLOS of 2,160,200 bbl 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. BOEM expects employment of cleanup workers to increase rapidly during Phase 2 and Phase 3, and peak during Phase 4. Revenue impacts from a hypothetical VLOS 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 impacts on economic activity that does not currently take place in the area (or that is currently not significant) but could exist in the future such as commercial fishing, recreational fishing, tourism, and increased Arctic marine shipping.

4.5.11. Subsistence-Harvest Patterns

A VLOS could affect subsistence-harvest patterns by altering overall subsistence harvest seasons. These alterations can occur due to:

- Displacement of and competition for resources
- Undesirability for use from contamination or perceived tainting
- Reduced numbers of resource species by deflection from oil spills or anthropogenic noise during remediation efforts
- Pursuit of resources becoming more difficult resulting in increased hunter effort
- Increased risk or cost of the subsistence effort caused by hunters traveling farther to harvest species
- Direct contact of oil with barrier islands and coastal shorelines could create toxic environments for subsistence resources and traditional harvests in these areas. Effects on subsistence-harvest patterns are provided in discussions located in previous sections. The importance of oil-spill analysis as an issue to local residents can be difficult to summarize. The following testimony however, 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, Point Hope, Alaska, June 22, 2011)

A VLOS during the open-water season could have effects on whaling, sealing, walrus hunting, ocean fishing and bird hunting. In winter, a VLOS could affect subsistence harvests of seals, walrus, fish, and polar bear. Disturbance could result in the extension of subsistence hunts by increasing the miles traveled and by hunters making frequent, longer trips to harvest adequate resources in a harvest season. The loss of subsistence-harvest patterns due to oil spills would cause harvest disruptions in the spring and summer, the primary hunting seasons (Galginaitis, 2014; Braund, 2013). These losses would be significant to subsistence hunters who regard these seasons as having primary importance and highest use for harvesting and sharing resources in the community. In the event of a VLOS contacting and extensively oiling habitats, cleanup of such a spill could bring the presence of work crews, boats, and aircraft and would result in anthropogenic noise that could displace subsistence species and alter or reduce subsistence-hunter access to resources in traditional harvest areas.

In other coastal areas of Alaska, marine subsistence species and general patterns of subsistence harvest and hunting area access have been impacted by spills in the past but have recovered as time passed. In Alaska, oil-spill fate and persistence have been documented in the 25 years since a spill of 258,000 bbl of oil occurred in Prince William Sound (Boehm et al., 2014). This research studied buried subsurface oil (SSO) and SSO residues (SSORs) over 20 years after the spill. Many data sets were collected and found that:

- Surface oil was removed rapidly, weathering to inert asphalt and generally observed on boulder/cobble shorelines
- SSO declined at a rate of ~80%/year in 1989-1992 to ~4%/year after 2001 with residues occurring in small isolated patches
- By 2009, most SSO on shorelines was present as light oil residue (lor) with minor amounts of scattered, sequestered heavy oil residue (HOR) and moderate oil residue (MOR). (Boehm et al., 2014)

Offshore, in the Chukchi Sea region, marine mammals are the most important subsistence resource, both culturally and nutritionally. If a VLOS were to occur, the bowhead whale hunt could be disrupted, as could hunts for beluga whale, bearded seal, and other marine mammals generally. As the spill occurs, and before it reaches shore, marine mammals traveling through the spill area during the open-water season could be contacted. During a winter spill, impacts would be intensified should entrained oil contaminate ice leads and surrounding shoreline. 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 wary, either because of the spill itself or from the hazing of marine mammals, a standard spill-response technique, to encourage them to leave the area affected by a spill.

In 2009, the United States Coast Guard (USCG) began a project to determine if operational demonstrations in their response to oil spills on ice in the Great Lakes could be used to evaluate technologies in the Arctic region (Hansen, 2014). Some conclusions of this research were that different recovery systems and tactics are necessary for different ice and weather conditions and that additional exercises under extreme cold and harsh weather (e.g. higher waves and wind) will keep improving lessons learned (Hansen, 2014). Hence, ongoing studies with under-ice or broken-ice oil spills are being considered by various governmental and private agencies such as Alaska Clean Seas (ACS). This group is the Alaska North Slope oil-spill response cooperative based in Prudhoe Bay, AK, having unique facilities to conduct ice research along with developing Arctic response experience and expertise. This group also delivers training for recovering oil spilled under ice to oil workers (Hall et al., 2014)

Of great concern to local residents are oil spills and their effects on subsistence-harvest patterns. While the concern most typically is 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 river deltas, as well as species that use oiled coastal and nearshore habitat, such as caribou and birds (see Sections 4.5.4, 4.5.5, 4.5.6, and 4.5.7).

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 way of life. Even if whales were available for the spring and fall hunts, tainting concerns could leave bowheads less desirable and alter or completely stop the subsistence hunt. Since communities unaffected by a potential spill would share bowhead whale products with impacted villages, the harvesting, sharing, and processing of other resources would continue. Concerns about tainting apply to marine mammals, fish and birds causing short-term effects on some populations. A potential loss of species utilized for subsistence would reduce their local availability for harvest. Oil-spill-cleanup activities could produce additional effects on subsistence activities, causing displacement of subsistence resources and difficulty by hunters accessing tradition use areas.

Although the VLOS would originate within the Chukchi Sea Leased Area, effects might be felt by communities remote from the Leased Area and far removed from the spill. These communities are located in the North Slope Borough, the Northwest Arctic Borough, the Bering Strait region, the Russian Chukotka region, and are analyzed in detail in Section 3.3.2. Concerns about subsistence harvests and subsistence food consumption would be shared by all Iñupiaq, Yup'ik, and Native Chukchi communities in the U.S. and Russian Chukchi and Bering Seas adjacent to the migratory corridor used by whales and other migrating species. Concerns about contaminated subsistence resources in these communities 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 polynya (open lead system) is an important habitat for marine mammals such as bowhead and beluga whales, walruses, seals, and other marine mammals. For an analysis of VLOS impacts to these species see Section 4.5.7.

Very large oil spills could affect subsistence patterns by reducing populations, contaminating subsistence resources or habitats, or rendering resources unfit to eat. These effects could reduce the amount of subsistence foods harvested, causing changes in traditional diets, increasing risks to hunters, and increasing use and cost of equipment due to increasing travel distance to obtain subsistence harvests. These effects could cause social stress due to the reduction or loss of preferred foods harvested in the traditional fashion and thereby cause effects to community health (USDOI BLM and MMS, 2003; USDOI, BLM, 2004, 2005, 2006; USDOI, MMS, 1987, 1990b, 1998, 2001, 2003, 2004, 2006a,c).

Effects of a VLOS on subsistence-harvest patterns are analyzed below for each of the five phases of the hypothetical scenario. The greatest potential for effects on subsistence-harvest patterns occurs during Phase 3 (Onshore Contact) and 4 (Spill Response and Cleanup). In all cases, long-term recovery of resources and subsistence-harvest practices is likely. Harvesting, sharing, and processing of subsistence resources would continue, but would be hampered to the degree these resources were actually or perceived as contaminated. Tainting concerns, in communities nearest the spill or near contacted coastlines, could seriously curtail their traditional practices of harvesting, sharing, and processing resources. Curtailment of these practices could threaten pivotal cultural and spiritual rituals in these communities and affect health and well-being. In the case of long term or extended contamination, harvests would cease until such time as local subsistence hunters perceived resources as safe. Any loss of subsistence-harvest patterns could be significantly deleterious to subsistence-dependent communities in many ways, impacting culture, health economics, and environmental justice. 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).

4.5.11.1. Phase 1 (Initial Event)

Direct impacts on subsistence-harvest patterns would likely be localized in the initial phases of the blowout event. Effects to substance-harvest patterns from news and images of the event would likely be traumatic to subsistence harvesters throughout the Chukchi Sea region. This would likely produce increased stress and anxiety over the safety and availability of resources and accessibility to harvest areas. Community fears about reduced or contaminated resources, contaminated habitats and harvest areas, reductions in the ability to harvest traditional foods, and concerns related to general food safety could all cause increases in social stressors (USDOI, MMS, 2007a).

4.5.11.2. Phase 2 (Offshore Oil)

In this phase, offshore resources could come into direct contact with spilled oil. 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, compromised traditional harvest areas, and was persistent in resource habitat areas, subsistence practices would be seriously curtailed, particularly bowhead whale hunting. This curtailment of subsistence hunting would be due to the same issues concerning contamination as analyzed in Phase 1. Further, this would create serious reductions in access to traditional nearshore harvest areas. Birds (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 seals, walrus, and polar bear would tend to avoid active drilling operations or in the case of walrus, would likely to avoid an active drilling operation (see Sections, 4.3.7 and 4.5.7).

Effects of a VLOS on important subsistence species during Phase 2 are analyzed below.

Bowhead Whales. In the event of a VLOS, 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 gets 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 may kill some whales. Whales travelling under the ice or feeding near the bottom could also experience contamination. In has been established that bowhead whales have olfactory bulbs which are histologically complex, suggesting that bowheads have a sense of smell (Thewissen et al., 2011). This research lends substantiation to Traditional Knowledge regarding the bowhead whale 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 4.5.7.

In some locations and during certain years, there have been 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 could be greater than typically assumed. BOEM cannot rule out effects to whale populations if a large number of females, newborns, 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 four years without cleanup, the event is remembered more vividly as a time of devastation and deprivation by those who directly witnessed effects of the spill or by those who were told of the event by witnesses. Not only were whales absent for four 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-harvest patterns.

Thomas Brower, Sr:

> 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) loss of food sources, and (6) temporary displacement from some feeding areas. Additional discussion of potential impacts to these marine mammals is provided in Section 4.5.7. In general, any VLOS could cause injury or death to these resources, potentially cause them to move off of their normal migratory course making them unavailable for subsistence harvesting.

A VLOS contacting areas near Point Lay could disrupt the beluga migration and deprive the community of its primary subsistence hunt. In some years and in some locations, there have been reported relatively large aggregations of feeding and molting beluga whales within the area. If a large amount of fresh oil contacted a significant portion of an aggregation, effects could be greater than typically assumed. Beluga population-level effects cannot be ruled out if a large number of females, newborn, or very young calves were contacted by a large amount of fresh crude oil (USDOI, MMS, 2007a). An effects analysis was completed on marine mammal species after a VLOS and results are provided in Section 4.5.7.

Polar Bears. If a VLOS occurred, impacts to polar bears could result. Impacts could occur if areas in and around polar bear habitats were oiled. Polar Bears have a low reproductive rate and due to loss of sea ice habitat, have a decreased ability to recover from changes related to oiling or habitat loss due to an oil-spill. Analysis of potential VLOS impacts to Polar Bears is provided in Section 4.5.8.

Birds. The effects on marine and coastal birds from contact with oil are analyzed in greater detail in Section 4.5.6. Many bird species important to subsistence harvests by the Chukchi Sea communities are associated primarily with coastal areas or on-ice hunting. Impacts to subsistence caused by oiling of birds during the offshore spill phase are presented within the Phase 3 discussion of onshore contact, below.

4.5.11.3. Phase 3 (Onshore Contact)

In this phase, more profound impacts to subsistence-harvest patterns would occur. Effects include:

- Onshore resource habitats and coastal harvest areas having direct contact with spilled oil
- Contamination of subsistence resources, resource habitats, and traditional subsistence harvest areas

- Curtailment or inability to use traditional food sources due to actual and/or perceived contamination

For subsistence-harvest patterns to fully recover, onshore habitats would need to be restored and access to harvest areas would need to continue.

Effects of a VLOS on important subsistence species during Phase 3 are analyzed below.

Seal, Walrus and Polar Bears. For seal and walrus, an oil spill impacting dens or coastal haulout areas could have a significant impact on these populations. In spring, seals come on land or on pack ice to give birth in small dens, in the snow, and on top of the ice. The same would be true if oil contacted polar bear dens. When ice floes break up in the fall, female polar bears dig a maternity den, most often in snowdrifts. However, many dens are situated on land a short distance from the coast, and polar bears can reuse the same denning areas each year. Polar bears that do not den on land make their dens on the sea ice, giving birth to cubs between November and February (Derocher et al., 2004). 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 Section 4.5.7).

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, could become oiled, and could eat contaminated vegetation. It is more likely animals would be deflected from contaminated areas by ongoing spill cleanup activity. During late winter- early spring, caribou move out on to the ice, licking sea ice for salt. By doing this, caribou would be exposed to oil if a spill contaminates the ice. If a VLOS occurred during the open-water season or during winter and subsequently 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. Contact and contamination would occur during periods of insect escape activities, usually during summer months. Caribou that become oiled through fur contamination are not likely to suffer the loss of thermo-insulation. Exposure pathways for Caribou by oil would be absorption through the skin and inhalation of hydrocarbon chemical vapors. Possible effects of oil ingestion in caribou can be weight loss and aspiration pneumonia leading to death. Similar effects would be expected for other terrestrial subsistence resource species that depend on beaches, mudflats, river mouths and coastal streams during the summer and fall. These resources are likely to ingest contaminated food and ingestion could result in species loss through kidney failure and other complications (USDOI, MMS, 2007a). (See Section 4.5.8).

Fish. A VLOS could affect offshore and nearshore fish species in the path of or near the oil through either direct effects (acute toxicity) or effects (e.g. shifts in prey availability). A VLOS impacting intertidal or estuarine spawning and rearing habitats used by subsistence fish could result in impacts to local fish breeding populations. Recovery to a species' former status after a VLOS by dispersal from nearby population segments would require more than three generations and thus, anadromous fish can be particularly impacted if oil reaches the mouth and delta of anadromous streams and rivers. Depending on timing, extent, and persistence of a VLOS, some distinct runs of certain species of salmon could be eliminated. Recovery from this impact would occur as strays from other fish populations colonized the streams after oiled habitats recovered. Hence, local fish stocks would not be available for subsistence harvests for years (See Section 4.5.5).

Birds. As described in Section 4.5.6, marine and coastal birds have the greatest potential for impacts from a VLOS which could come in contact with coastal bird habitats used for subsistence harvests. Primary bird hunting and egg harvesting occurs for Barrow at locations north and west from Point Barrow to Peard Bay, Wainwright harvesting occurs from Point Franklin to Pingorarok Pass, and Point Hope and Point Lay harvest from Kasegaluk Lagoon, to Naokok Pass (Braund, 2013). Other important areas to subsistence harvesting of birds and eggs are barrier islands, the spring open-water lead system, and the seabird-nesting colonies at Cape Lisburne and Cape Thompson. These areas provide important nesting, molting, and migration habitat to a variety of waterfowl and shorebirds, and a VLOS could impact large number of murres, puffins, and kittiwakes at the Cape Lisburne and Cape Thompson colonies. Oil spills have the greatest potential for affecting large numbers of birds due to toxicity to individual birds, by contamination of their prey, and by difficulties involved in oil-spill cleanup in remote areas and a wide variety of vegetative and/or ice conditions. Potential mortality could result in impacts to colonies and to pelagic distributions of auklets and shearwaters during the open-water period and male and juvenile murres in the late summer. A spill during periods of peak use by migratory birds 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 and loss of up to 45% of the Pacific Flyway population would have conspicuous population-level effects. This would have direct effects on the subsistence use of brants and the numbers which could be harvested. The situation described for brants would be similar to other 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 hunts, year-round bird hunting, and egg gathering to be of primary importance.

Subsistence Practices

A VLOS could affect subsistence patterns by the following:

- Reducing populations of subsistence species
- Reducing availability of subsistence species
- Contaminating subsistence species or their habitat
- Actual or perceived tainting concerns in resources; and
- Rendering resources unfit to eat

These effects from a VLOS would reduce the amount of subsistence foods harvested, result in changes in traditional diets, increase risks to hunters from longer distance traveled while hunting, increase wear and costs on equipment due to hunters traveling farther to obtain subsistence resources. Marine mammals are the most important subsistence resource, both culturally and as food, for these regions. The bowhead whale hunt could be disrupted, as could the beluga hunt. A VLOS would also disrupt hunts for seal, walrus, and other marine mammals. Animals could be directly oiled or oil could contaminate the ice used during migration. Contaminated animals would be considered undesirable or they could be more difficult to hunt due to physical and environmental conditions which are less than optimal. As analyzed previously, in 2009, research is being conducted to evaluate on-ice and under-ice oil-spill technologies in the Arctic (Hall et al., 2014).

Subsistence resources would also experience tainting and disturbances from a VLOS. An oil spill affecting any part of the migration routes of bowhead or beluga whales or other marine mammals could taint these resources, a culturally pivotal to the subsistence way of life of the Iñupiat. Even if whales were available for spring and fall hunts, tainting concerns would make bowheads and belugas less desirable and could alter or completely stop subsistence hunting of this resource. Communities in the region, but unaffected by a potential spill, would share bowhead whale products with communities who are impacted. Therefore, it is anticipated that harvesting, sharing, and processing of uncontaminated resources would continue (USDOI, MMS, 2007a).

While tainting concerns are most typically expressed as a relationship to potential oil spills and resulting effects on whales and subsistence whale hunting, it is also a concern for marine mammals and other ocean resources used for subsistence. Concerns about tainting apply to other marine mammals: bearded, ringed, and spotted seals, walrus, and polar bears. A potential loss of these resources would reduce their availability to subsistence users. Marine mammals and fish typically comprise 60% of a coastal community's diet and it has been frequently stated during public testimony that "The sea is my garden." A VLOS could impact other migrating resources such as anadromous fish and birds due to the chemical constituents of the oil and their potentially toxicity immediately affecting fish. This contamination could be present for years, even in apparently cleaned habitats (Boehm, 2014). Birds that use (potentially oiled) coastal and nearshore habitats, such as nesting birds would be impacted. Terrestrial mammals, caribou, bears, fox, wolves, and wolverines could be oiled, contaminated, or even killed. These subsistence resource populations could ultimately die from hypothermia caused by oiling, reactions to toxic components of spilled oil, and gastric distress resulting from attempts to clean themselves and any scavenger species feeding on remains of a carcass could become contaminated (USDOI, MMS, 2007a).

Oil-spill cleanup and its effects on subsistence activities would cause a potential displacement of subsistence resources. This would cause subsistence hunters to work harder and travel farther to obtain food. Even if oil-spill effects to a subsistence resource did not affect a species' distribution or population, disturbance from a VLOS could affect subsistence hunting in the following ways:

- Increasing the distance hunters travel to locate and harvest resources
- Increasing the number and time of trips necessary to harvest enough resources during a season. Major effects to specific subsistence species and to general patterns of subsistence resource hunting and gathering persisted in Prince William Sound for several years after the Exxon Valdez Oil Spill and subsequent cleanup effort. That event affected community subsistence patterns. However, in the 25 years since the spill, research shows that the ecosystem has essentially recovered and continues to improve with time (5).

A spill originating within the Leased Area would produce effects felt by communities away from the Leased Area and located away from the spill. Communities closest to the Leased Area and most likely to be contacted if a VLOS were to occur are Barrow, Wainwright, Point Lay and Point Hope. Communities away from the Leased Area are located in the Northwest Arctic Borough, Bering Strait, and the Russian Chukotka regions and concerns about subsistence-harvest patterns and the safety of subsistence food consumption would be shared by all Iñupiat and Yup'ik Eskimo in these communities. Another concern would arise with regard to a reduction in the whale strike quotas. An unlikely but potential effect from tainting could be that the International Whaling Commission (IWC), which sets bowhead whale strike quotas for the Iñupiat subsistence harvest, could reduce the numbers following a major oil spill. This could be done to ensure that overall whale population mortalities would not increase. Such a move would have profound cultural and nutritional impacts on whaling communities by minimizing the ability for communities to practice this cultural and spiritual ritual, by decreasing the numbers of whales to be harvested, and by decreasing food supplies for community members.

Tainting concerns could seriously curtail the harvesting, sharing, and processing of subsistence resources. These practices would be curtailed to the degree these resources were contaminated. Areas directly oiled along with offshore and onshore areas used for staging for oil-spill response, would not be available for use by subsistence hunters for some time following a spill. Oil contamination of beaches would have impacts on whaling. These impacts would be due to shoreline contamination causing Iñupiat subsistence whalers and other hunters to be unable to bring whales and other marine mammals ashore or on ice to butcher and prepare them. In the case of extreme contamination of whales, harvests could cease until such time as resources were perceived as safe for harvest by subsistence hunters and safe for consumption by community members. Because all communities in the Chukchi Sea and Bering Strait regions 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 this culturally preferred food which is harvested in the traditional fashion. The loss of hunting and harvesting whales threatens a pivotal element of indigenous Alaska culture. To determine the effects of a VLOS on subsistence-harvest patterns, avoidance by subsistence users would be a critical element for analysis and this avoidance would vary depending on the timing and the volume of a spill, the persistence of oil in the environment, the degree of spill impact on subsistence-harvest patterns, the time necessary for recovery of a subsistence species, and community confidence that resources are safe to eat. VLOS oil-spill effects would be considered major (USDOI, MMS, 2007a, 2011 SEIS).

Russian Arctic Chukchi Sea Coastal Communities. Depending on the location and trajectory of the hypothetical VLOS, coastal communities in Russian located on the western side of the Chukchi Sea, could experience impacts to their subsistence-harvest patters. Potentially, important coastal lagoons and nearshore subsistence harvest areas for gray, beluga, and bowhead whales, walrus, seals, fish, birds, other marine and terrestrial mammals, and sea plant resources could be contacted in the event of a VLOS. As explained in Chapter 3, changes in the Russian Chukotka region have taken a huge toll on the indigenous people living in the region. As these communities reconnect and resume their traditional subsistence way of life, they turned toward their traditional reliance on hunting and fishing. In 2014, the Wildlife Conservation Society, held a conference on oil-spill response in the Bering and Anadyr Straits looking at concerns related to spills and their effects on subsistence communities and food security after a spill. Findings from this conference which indicate that effects from a VLOS could exacerbate existing stressors in subsistence communities. This could cause and inability to conduct subsistence hunts and harvesting. A VLOS could cause a disruption to these communities, diminishing harvests, which they conduct as described in Chapter 3.

4.5.11.4. Phase 4 (Spill Response and Cleanup)

In this phase, more profound impacts to subsistence-harvest patterns would occur. During spill response and cleanup, disturbances to resources would not only occur from oil contamination, but also from real or perceived contamination from the spill, noise, or habitat alteration. Other disturbances to subsistence-harvest patterns would come from: (1) vessels and aircraft supporting cleanup efforts; (2) relief well drilling, (3) in-situ burning of spilled oil; (4) hazing and capture of wildlife; (5) dispersant use; (6) bioremediation; and, (7) beach cleaning. In addition, the physical presence of cleanup workers could disrupt traditional subsistence practices. Spill cleanup would provide an opportunity for local, high paying wage work and would likely displace many local hunters from traditional subsistence-harvest pursuits. Cleanup for a VLOS could disrupt subsistence harvest activities for at least an entire season. This disruption would be due to oil-spill employment during cleanup potentially causing hunters to be unable to take time for traditional hunting and the contamination of hunting use area.

Effects of a VLOS on primary subsistence species and harvest practices are analyzed below. Disturbance to bowhead, beluga, and gray whales, seals, polar bears, fish, birds, caribou, other terrestrial mammals, and marine and terrestrial vegetation would increase from oil-spill-cleanup activities. Activities during cleanup include aircraft overflights, relief well drilling activities and in-situ burning. Some equipment used during this time includes skimmers, workboats and barges. These activities and the use of equipment during cleanup could cause whales to be temporarily displaced, altering their migration pathways and causing them to avoid traditional use areas. Such displacement could cause whales and other marine mammals, including seals, which use ice-covered or broken-ice, to avoid areas where they are normally harvested. They may become more wary and difficult to harvest. Nearshore and onshore, small vessels, cleanup crews, support vehicles, and heavy equipment could disturb coastal subsistence resource habitats, displace subsistence species, reduce hunter access to traditional hunting use areas or species, and alter or extend the annual subsistence hunt. These activities should be viewed as an additional impact, potentially causing displacement of subsistence resources and subsistence hunters (Impact Assessment, Inc., 1998). (See 4.3.5 Fish, 4.3.6 Marine Mammals. 4.3.8 Terrestrial Mammals, and 4.3.6 Marine and Coastal Birds).

Bowhead Whales. There are no described observations concerning the level of disturbance on bowhead whales from cleanup activities. However, the presence of offshore skimmers, workboats, barges, aircraft overflights, and in-situ burning during cleanup may be expected to cause temporary alterations in whale behavior. These alterations can include alterations of migration pathways 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). However, if oil was embedded in the ice and were to become free during breakup and at the opening of the polyna, bowhead whales could be contacted (See Section 4.5.7).

Beluga Whales, Seal, Walrus, and Other Marine Mammals. In the case of a VLOS during winter, with few subsistence resources present, and ice still present, cleanup measures would tend to reduce impacts prior to beluga whale migrations. Cleanup measures would also reduce impacts to other marine mammals as they return to the area during the spring and summer months. Ringed seals are common near the communities during the winter and are harvested by Barrow year round. Barrow hunts for seal occur on ice during winter months. They also hunt seal during the open-water season; summer and early fall (Braund, 2013; Braund, 2010). It is possible that cleanup operations could displace some ringed seals from maternity dens during the winter, resulting in the loss of some seal pups. Walrus are hunted by the communities of Barrow, Wainwright, Point Lay, Point Hope, and Atqasuk, primarily during summer and fall. If a VLOS occurred, contacting and extensively oiling coastal habitats during the open-water season, the presence of cleanup crews, vessels, and aircraft operating in the cleanup response area is expected to displace beluga whales, seals, and walrus. This would contribute to increased stress on these subsistence resources, potentially making them unavailable for harvest (Braund, 2013; Braund, 2010, Impact Assessment, Inc., 1998) (Section 4.5.7).

Polar Bears. If a VLOS ocurred, as previously analyzed, cleanup activities in the area are expected to displace polar bears. It is possible that there could be a displacement of bears from maternity dens during the winter, resulting in the loss of some 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, 2003, USDOI, BLM, 2012).

Caribou and Other Terrestrial Mammals. If a VLOS contacted coastal habitats and extensively oiled those containing herds or bands of caribou during the insect season, the presence of cleanup crews, vessels, and aircraft operating in the area of cleanup response is expected to cause displacement of caribou and could seriously stress elements of the herd. This could result in some mortality and/or decreased productivity. Cleanup operations at the spill site could frighten animals away from the contacted area, preventing 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 (USDOI, BLM, 2006; USDOI, MMS, 2003). Other terrestrial mammals utilized for subsistence can also be affected if they become oiled or displaced from their habitat. This would result in reduced availability to communities (Section 4.5.8).

Fish. Oil-spill-cleanup activities in open water or in broken ice may affect fish utilized for subsistence. Onshore cleanup is likely to add little to the toxic oil contact impacts to fish resources described above (USDOI, MMS, 2003).

Birds. Spill response activities could disturb and displace marine and coastal birds, which could have net beneficial effects. These effects would come from the spill, 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 oiled habitat areas 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 marine and coastal birds could physically relocate to other areas, those areas may be unsuitable and delay recovery (Section 4.5.6).

Subsistence Practices. Spill-cleanup strategies could potentially reduce the amount of spilled oil in the environment and tend to mitigate contact and contamination effects. In the case of a winter spill, fewer subsistence resources would be present and cleanup is likely to be more effective. During an open water or spill during icebreakup, disturbance to bowhead and beluga whales, seal, walrus, and other marine mammals including polar bear, fish, birds, caribou, and other terrestrial mammals would increase due to activities from oil-spill cleanup. Cleanup activities and equipment analyzed previously, could cause disruptions to subsistence-harvest patterns resulting in temporary displacement of whales during spring migrations. These disruptions could also result in some animals avoiding areas where they are normally harvested, causing them to become more wary, and resulting in more difficulty during hunting season and less easily harvested. Cleanup activities could affect other subsistence species near these activities. Crews and vessels offshore, support vehicles, and heavy equipment onshore would disturb coastal resource habitat, displace subsistence species, alter or reduce subsistence-hunter access to these species, and alter or extend the normal duration of the subsistence hunts.

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). Another disruption to hunting activities would be caused by the response of cleanup crews. These crews may require local knowledge, experience, and vessels belonging to whaling captains in the community as expert resources. By utilizing these resources, this diverts the captains and their equipment to oil-spill cleanup activities with the potential to impact subsistence whale hunting or other hunting activities due to cleanup work commitments. Oil-spill-cleanup activities should be viewed as an additional impact, potentially causing displacement of subsistence resources, delaying or stopping hunts altogether, and impacting subsistence hunters by increasing time and distance they need to harvest resources. The overall result would be a major effect on subsistence harvests and those in the community who depend on subsistence. These individuals and communities would suffer, due to the loss of subsistence resources and the ability to harvest resources, impacts to cultural and spiritual values, overall nutritional status and subsequent effects to community health status, and mental well-being. These impacts will be analyzed with more detail in Sections 4.5.12, 4.5.13, and 4.5.14. Impacts to subsistence harvests would be moderate as subsistence harvest would likely be disrupted for a substantial portion of a season. Cleanup of the Exxon Valdez Oil Spill took more than four summers (Exxon Valdez Oil Spill Trustee Council, 2014). If this were the case in this VLOS scenario, then effects could become major if cleanup activities persisted longer than one season.

4.5.11.5. Phase 5 (Long-term Recovery)

In this phase the impacts to subsistence-harvest patterns would occur from: (1) unavailability or increased difficulty in obtaining and utilizing subsistence resources; (2) long-term contamination stemming from the oil spill; (3) perceptions that resources are contaminated, altering traditional use patterns; (4) co-opting of human resources and equipment required to study long-term impacts of the spill, and (5) psychological and social distress to the communities and their members which would occur from long-term impacts due to a VLOS.

Effects of a VLOS on important subsistence species and the resulting effects on subsistence harvests during Phase 5 are analyzed below.

In the long-term recovery phase, subsistence resource impacts would transform into sociocultural impacts (analyzed in depth in Section 4.5.12) and the ability to separate these impacts into separate and distinct parts is difficult if not nearly impossible. This difficulty comes since subsistence is intertwined with sociocultural systems, community health and EJ. Long-term subsistence impacts from a VLOS and its cleanup activities would create a perception of chronic disruptions to bowhead whale harvests. Any actual or perceived tainting of the whale meat anywhere during the time the bowhead whale passes through the Leased Area during migration could cause effects that would be evidenced by long-term disruptions in harvest patterns leading to a potential breakdown of kinship networks, sharing patterns, and increased social stressors in the community (Solomon, 2014).

Cleanup participation, as local residents did in the Exxon Valdez Oil Spill in 1989, could be a disruptor of subsistence harvests. Participation in cleanup activities could cause:

Non-participation in subsistence activities

Those in the communities who would work on spill activities could see a surplus of cash that they might spend on material goods or possibly drugs and alchohol

Community members may not seek or continue employment in other jobs since oil-spill-cleanup wages are usually higher than average (Aldy, 2014)

Indications are that the sudden, dramatic increase in income earned from working on cleaning up during the Exxon Valdez Oil Spill and being unable to pursue subsistence harvests due to this wage work, caused a tremendous amount of social upheaval. This was indicated by reported increases in depression, violence, and substance abuse, although it is impossible to predict what the impacts in any particular community would be (Picou et al., 1992; Cohen, 1993; Picou and Gill, 1993; Fall, 1992; Impact Assessment, Inc., 1990a,b; Fall and Utermohle, 1999; Human Relations Area Files, Inc., 1994a, b, c). It can be said that generally, after a VLOS, it is expected that considerable stress and anxiety would occur over the loss of subsistence-harvest patterns, contamination of resources, fear of the health effects of eating contaminated wild foods, fear of changes to harvest regulations (i.e., IWC strike quotas, state or Federal bans on consumption of resources), and the need to depend on the knowledge of others about environmental contamination (Fall, 1992, McMullen, 1993). Individuals and communities would be increasingly stressed as they developed new, modified subsistence-harvest patterns by selectively changing harvest areas. If harvest areas were far away or unfamiliar, there would be increased safety risks and costs 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 (See Section 4.5.12 Sociocultural Systems; 4.5.13 Public Health).

Community sharing of the bowhead whale, a culturally significant subsistence resource, could, if multiyear disruptions of subsistence-harvest patterns were to occur, be disrupted. Effects of long-term recovery could impact subsistence-task groups, whaling crew structures, and would cause disruptions to Iñupiat cultural values central to the subsistence way of life. These disruptions could cause a breakdown in sharing patterns, family ties, and the community's sense of well-being. These disruptions can result in damaging the sharing linkages with other communities. Other effects might be a decreased emphasis on subsistence as a livelihood, with 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 one harvest season. As in the Exxon Valdez Oil-spill cleanup, it took more than four summers to cleanup (Exxon Valdez Oil Spill Trustee Council, 2014). If a VLOS were to take four summers or four seasons, this could result in higher effects on subsistence, sociocultural patterns, community health, and EJ for a much longer time than the period subsistence resources may be measurably contaminated. In general, a decline in the certainty about potential displacement of subsistence resources, hunter safety, changes in community sharing, and the safety of consuming subsistence foods could lead to a loss of community solidarity. Communities farther from the area contacted by the spill would need to assist communities affected by acquiring subsistence foods to share due to necessity, and thus, potentially taxing the resources of other subsistence regions and their communities (USDOI, MMS, 2007a).

In 1989, the Exxon Valdez Oil Spill was considered "ground zero" for sociocultural and psychological impacts from a VLOS (Gill and Picou, 2014). Research conducted in the 25 years since the spill utilized both quantitative and qualitative methodological designs with the ecological-symbolic theory and the reNWABle resource community (RRC) concept to frame community, group, and individual responses to this environmental disaster (Gill and Picou, 2014). The effects of long-term recovery after a VLOS may cause communities whose cultural survival is tied to the traditional use of food to be affected in the following ways:

- 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 around seasonal harvest distribution and use of foods
- The lingering presence of oil in the environment leads to continuing avoidance of subsistence harvest resources
- Loss of subsistence-food harvests and use did not necessarily lead to long-term cultural losses (cultural knowledge, skills, or values within families)
- Concerns about contamination of subsistence resources and the safe consumption of these resources would persist with confidence in the benefits of eating natural foods decreasing
- According to Gill and Picou (2014), qualitative findings have revealed that after the VLOS in Prince William Sound, the lack of ecosystem recovery and resulting lack of subsistence harvests was a factor for chronic psychological stress and community disruption

Impacts in the first year following the Exxon Valdez Oil Spill included subsistence harvest impacts which are directly connected to sociocultural impacts: collective trauma in the communities, social disruption, community conflict, economic uncertainty, and psychological stress (Gill and Picou, 2014). The initial spill disrupted the subsistence harvests of fifteen Alaska Native communities for resources such as seal, shellfish, fish, waterfowl, and deer. Oil affected these resources by reducing the availability of the resources, concern about possible health effects when eating oiled fish and wildlife, and disruption if the traditional way of life due to cleanup activities. Directly after the spill, subsistence harvests declined between 9 to 77% in ten Native villages affected by the spill. By 2003, subsistence harvests increased but were not as high as pre-spill harvests. In 2010, the Exxon Valdez Oil Spill Trustee Council reported in their "2010 Status of Injured Resources and Services" that many subsistence species were recovered or recovering but that harvest levels were still down as 83-percent of Alaska Native residents felt that their "traditional way of life" had been injured by the spill and 74-percent believed that recovery had not occurred since the spill (Exxon Valdez Oil Spill Trustee Council, 2014) (See Sections 4.5.12 Sociocultural Systems, 4.5.13, Public Health, 4.5.14 Environmental Justice).

4.5.11.6. Oil-spill Trajectory Analysis

The potential impacts to subsistence-harvest patterns during each phase of the hypothetical scenario are addressed above. BOEM uses 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 VLOS in the Chukchi Sea contacting specific ERAs and LSs that are important as traditional harvest areas or for subsistence resource concentrations. An ERA is a hypothetical polygon that represents a geographic area important to subsistence resource species' use and subsistence harvests for that geographic area within a specific season. The ERA locations are illustrated in Appendix A, Maps A-2a to A-2f. The ERAs important to subsistence-harvest patterns are identified in Appendix A, Table A.1-12.

Vulnerability of an ERA is based on the seasonal use patterns by subsistence resource hunters and listed in Appendix A, Table A.1-12.

Given the numbers of resources and marine harvest areas utilized by Chukchi Sea subsistence communities in the North Slope Borough, as well as those in the Northwest Arctic Borough, the Bering Strait region, and the Russian Chukotka coastal region, it is likely that many of these areas would be contacted by a VLOS. Areas analyzed by the OSRA model are included in this analysis. However, the OSRA model does not include trajectories for communities located outside of the model area: Wales, Diomede, Gambell, and Savoonga. These communities are located just south of Boundary Segments 1 and 2 (Map A-1) but will be discussed during analysis since they share subsistence resources which migrate both north and south through the Leased Area. The hypothetical VLOS could contact many areas while avoiding others entirely, depending on the location of the spill, the location of the ERA, or on the location of specific LSs.

A VLOS contacting ERAs or LSs, during the open-water season, could affect subsistence hunting and harvesting of whales, seals, walrus, polar bear, other marine mammals, fish, birds and eggs, caribou, moose, other terrestrial mammals, and the harvest of marine and terrestrial plant resources.

For each community below, the following tables summarize the percentage of trajectories from LAs 1, 4-6 and 10-11 during summer 60 and 360 days and for winter 360 days. These results are located in Appendix A: Tables A.2-28, A.2-30, A.2-34, A.2-36, A.2-54and A.2-60. The analysis tables below are organized by community starting with North Slope Borough communities (excluding Kaktovik with a percent trajectory in summer and winter <0.5%). The NSB communities analyzed include: Barrow (Table 4-73), Wainwright (Table 4-76), Point Lay (Table 4-77), Point Hope (Table 4-78), and Nuiqsut (Table 4-79). These are communities located closest to the Leased Area and it is anticipated effects from a VLOS would impact these communities first. There will then be a brief analysis of communities in the Northwest Arctic Borough and the Russian Chukotka Region (Table 4-80). Maps showing the ERAs, LSs, and Boundary Segment (BS) locations discussed are located in Appendix A: ERAs (Maps A-2a to A-2f), LSs (Maps A-3a to A-3c), and BSs (Map A-1).

Conditional Probabilities. 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 important subsistence ERAs and LSs that are important to subsistence-harvest patterns.

A VLOS contacting important subsistence ERAs or LSs during the open-water season, could affect subsistence hunting and harvesting of whales, seals, walrus, other marine mammals, fish, birds and egg gathering, terrestrial mammals, and the harvest of marine and terrestrial plant resources.

In the North Slope Borough, the communities of Barrow, Wainwright, Point Lay, Point Hope, and Nuiqsut are considered in this VLOS analysis. A brief analysis of Far East Russia is also considered here as it relates to a VLOS. For this discussion, land segments related to subsistence harvest locations and the 2-3 most harvested resources for each community will be analyzed. For a more in-depth discussion of subsistence-harvest patterns see Section 3.3.2 Subsistence-Harvest Patterns.

The percent trajectories contacting ranges between <0.5 and 35% for all ERAs and associated communities. In the NSB, ERAs for Wainwright have the highest percent trajectories contacting and Nuiqsut, the lowest. A VLOS in summer has a slightly higher percent of trajectories contacting than a VLOS in winter. Within 60 days, whale migration corridors, whale habitat, and subsistence-whaling areas in the Chukchi Sea (both Russian and American waters), which are considerably closer to the Leased Area, having a higher percent of trajectories contacting.

Barrow – The percent of trajectories contacting during summer within 60 and 360 days is up to 8% (Table 4-75). In winter, percentage of trajectories contacting within 360 days is up to 3%. Barrow (ERAs 41-42) primarily hunts for bowhead whales and bearded seal. Bowhead harvest occurs as far offshore as 35 km (22 mi) and bearded seal can occur as far offshore as 32 km (20 mi). Bowhead harvests occur in spring near Skull Cliff (LS 82) and near the Walakpa River (LS 84). In fall, whale hunts vary based on the migration of the whales and can occur offshore of several LSs. Bearded seal are hunted between Wainwright (LS 79) and Skull Cliff (LS82).

Table 4-75. Barrow-Summer or Winter Fraction of VLOS Contacting a Certain ERA or LS.[1]

Season / Analysis Period	% Range to ERAs ≥0.5%	ERA IDs with any value ≥0.5%
Summer 60 days	4-8	42
Summer 360 days	5-8	42
Winter 360 days	1-3	41, 42
Season / Analysis Period	**% Range to LSs ≥0.5%**	**LS IDs with any value ≥0.5%**
Summer 60 days	1-6	80-85
Summer 360 days	1-7	80-85
Winter 360 days	1-2	80, 83-85
Geographic Name of Land Segments Contacted in Alaska: LS80 Eluksingiak Point, Igklo River, Kugrua Bay; LS81 Peard Bay, Point Franklin, Seahorse Islands, Tachinisok Inlet: LS82 Skull Cliff: LS83 Nulavik, Loran Radio Station: LS84 Walakpa River, Will Rogers and Wiley Post Memorial; LS85 Barrow, Browerville, Elson Lagoon Name of ERAs Contacted: ERA 41 SUA: Barrow – Chukchi, ERA 42 SUA: Barrow - East Arch		

Notes: [1] Fraction of a VLOS (expressed as a percent of trajectories) Contacting a Certain ERA or LS Within 60 or 360 days During Summer or Winter from Any LA.

Appendix A, Tables A.2-28, 30, 34, 36, 54, 60,Maps A-2c, 2f, A-3b LA= Launch Area, ERA = Environmental Resource Area, LS = Land Segment

Wainwright – The percent of trajectories contacting during summer within 60 and 360 days is up to 35% (Table 4-76). The percent of trajectories contacting during winter within 60 and 360 days is up to 24% (Table 4-76). Wainwright (ERA 40) resources which could be affected by a VLOS in summer (June-August) are primarily bowhead and beluga whales utilized for subsistence. In Wainwright, subsistence resources harvested during summer also include bearded seal, their most harvested resource. For this harvest, hunters may travel up to 59 km (37 mi) offshore from Icy Cape (LS 75) to Peard Bay (LS 81). Beluga whales are generally harvested in Wainwright Inlet (LS 79) and bowhead whales are generally harvested from Point Franklin (LS81) to Pingorarok Pass (LS 68). These resources could be affected by a VLOS within 60 days, impacting beluga whale hunts which occur in shallow waters during July.

Table 4-76. Wainwright-Summer or Winter Fraction of VLOS Contacting an ERA or LS.[1]

Season / Analysis Period	% Range to ERAs ≥0.5%	ERA IDs with any value ≥0.5%
Summer 60 days	7-34	40
Summer 360 days	7-35	40
Winter 360 days	3-24	40
Season / Analysis Period	**% Range to LSs ≥0.5%**	**LS IDs with any value ≥0.5%**
Summer 60 days	1-4	73-82
Summer 360 days	1-4	73-82
Winter 360 days	1-2	74-76, 78-80
Geographic Name of Land Segments Contacted in Alaska: LS73 Akunik Pass, Tungaich Point, Tungak Creek; LS74 Kasegaluk Lagoon, Solivik Island, Utukok River; LS75 Akeonik, Icy Cape, Icy Cape Pass; LS76 Akoliakatat Pass, Avak Inlet, Tunalik River; LS77 Mitliktavik, Nivat Point, Nokotlek Point, Ongorakvik River; LS78 Kilmantavi, Kuk River, Point Collie, Sigeakruk Point; LS79 Point Belcher, Wainwright, Wainwright Inlet; LS80 Eluksingiak Point, Igklo River, Kugrua Bay; LS81 Peard Bay, Point Franklin, Seahorse Islands, Tachinisok Inlet: LS82 Skull Cliff **Name of ERAs Contacted**: ERA 40 SUA: Icy Cape – Wainwright		

Notes [1] Fraction of a VLOS (expressed as a percent of trajectories) Contacting a Certain ERA or LS Within 60 or 360 Days During Summer or Winter From Any LA.

Appendix A, Tables A.2-28, 30, 34, 36, 54, 60, Maps A-2a, A-3b LA= Launch Area, ERA = Environmental Resource Area, LS = Land Segment

Point Lay – The percent of trajectories contacting during summer within 60 and 360 days is up to 11% (Table 4-77). In winter, percentage of trajectories contacting within 360 days is up to 5%. Point Lay (ERA 39) primarily hunts for bearded seals, beluga whales and bowhead whales. Bearded seal hunts occur as far offshore as 24 km (15 mi) and from Omalik Lagoon (LS 69) to Wainwright (LS 79). Beluga whales are hunted in Kasegaluk Lagoon (LS 74) and bowhead whales are hunted from Utukok Pass (LS 74) to directly off Point Lay (LS 72).

Table 4-77. Point Lay-Summer or Winter Fraction of VLOS Contacting a Certain ERA or LS.[1]

Season / Analysis Period	% Range to ERAs ≥0.5%	ERA IDs with any value ≥0.5%
Summer 60 days	1-11	39
Summer 360 days	1-11	39
Winter 360 days	1-5	39
Season / Analysis Period	**% Range to LSs ≥0.5%**	**LS IDs with any value ≥0.5%**
Summer 60 days	1-2	71-76
Summer 360 days	1-2	71-76
Winter 360 days	1-1	74-76
Geographic Name of Land Segments Contacted in Alaska: LS71 Kukpowruk River, Naokok, Naokok Pass, Sitkok Point; LS72 Epizetka River, Kokolik River, Point Lay, Siksrikpak Point; LS73 Akunik Pass, Tungaich Point, Tungak Creek; LS74 Kasegaluk Lagoon, Solivik Island, Utukok River; LS75 Akeonik, Icy Cape, Icy Cape Pass; LS76 Akoliakatat Pass, Avak Inlet, Tunalik River **Name of ERAs Contacted:** ERA 39 SUA: Point Lay – Kasegaluk		

Notes: [1] Fraction of a VLOS (expressed as a percent of trajectories) Contacting a Certain ERA or LS Within 60 or 360 Days During Summer or Winter from Any LA.

Appendix A, Tables A.2-28, 30, 34, 36, 54, 60, Maps A-2c, A-3b, LA= Launch Area, ERA = Environmental Resource Area, LS = Land Segment

Point Hope – The percent of trajectories contacting during summer within 60 and 360 days is up to 4% (Table 4-78). In winter, the percent of trajectories contacting within 360 days is up to 4%. Point Hope (ERA 38) primarily hunts bowhead whales, beluga whales, and polar bears. Bowhead hunts are conducted near the community in various land segment locations.

Table 4-78. Point Hope-Summer or Winter Fraction of VLOS Contacting a certain ERA or LS.[1]

Season / Analysis Period	% Range to ERAs ≥0.5%	ERA IDs with any value ≥0.5%
Summer 60 days	1-4	38
Summer 360 days	1-4	38
Winter 360 days	1-4	38
Season / Analysis Period	**% Range to LSs ≥0.5%**	**LS IDs with any value ≥0.5%**
Summer 60 days	1-2	64-66
Summer 360 days	1-2	64-66
Winter 360 days	1-1	64-66
Geographic Name of Land Segments Contacted in Alaska: LS64 Aiautak Lagoon, Ipiutak Lagoon, Kowtuk Point, Kukpuk River, Pingu Bluff, Point Hope, Sinigrok Point, Sinuk; LS65 Buckland, Cape Dyer, Cape Lewis, Cape Lisburne; LS66 Ayugatak Lagoon Name of ERAs Contacted: ERA 38 SUA: Point Hope - Cape Lisburne		

Notes: [1] Fraction of a VLOS (expressed as a percent of trajectories) Contacting a certain ERA or LS Within 60 or 360 Days During Summer or Winter From Any LA.

Appendix A, Tables A.2-28, 30, 34, 36, 54, 60, Maps A-2f, A-3b , LA= Launch Area, ERA = Environmental Resource Area, LS = Land Segment

Nuiqsut – The percent of trajectories contacting during summer within 60 and 360 days is up to 3% during summer (Table 4-79). In winter, the percent of trajectories contacting within 360 days is up to 1%. Point Hope (ERA 43) primarily hunts bowhead whales, beluga whales, and polar bears. Bowhead hunts are conducted from Cross Island with other hunts conduced in areas surrounding the community in various land segment locations.

Table 4-79. Nuiqsut-Summer or Winter Fraction of VLOS Contacting a Certain ERA or LS.[1]

Season / Analysis Period	% Range to ERAs ≥0.5%	ERAs with any value ≥0.5%
Summer 60 days	1-3	43
Summer 360 days	2-3	43
Winter 360 days	1-1	43
Season / Analysis Period	**% Range to LSs ≥0.5%**	**LSs with any value ≥0.5%**
Summer 60 days	NA	NA
Summer 360 days	NA	NA
Winter 360 days	NA	NA
Name of ERAs Contacted: ERA 43 SUA: Nuiqsut - Cross Island		

Notes: [1] Fraction of a VLOS (expressed as a percent trajectories) Contacting a Certain ERA or LS Within 60 or 360 days During Summer or Winter from Any LA.

Appendix A, Tables A.2-28, 30, 34, 36, 54, 60, Maps A-2d, A-3b LA= Launch Area, ERA = Environmental Resource Area, LS = Land Segment, NA=Not applicable

Northwest Arctic Borough Communities: (Kivalina, Kotzebue and Surrounding Communities, Shishmaref, and Wales) –There is no table for these communities since the percentage of trajectories contacting ERA13 (Kivalina/ Kotzebue or ERA5 Shishmaref/Wales) is <0.5% for summer or winter within 60 or 360 days. All LSs which correspond with these ERAs (Land Segments 40-63) have <0.5% trajectories contacting within all the seasons, time periods, and from all LAs. This analysis differs from the 2007 FEIS which showed ranges from <0.5-2% from LA 9 or PL1. No leases were issued in LA 9 and its hypothetical pipeline is no longer a part of the Leased Area analyzed.

Far East Russian communities – The percent trajectories contacting during summer within 60 and 360 days is up to 4% (Table 4-80). LSs for this region in summer have potential contact of 1-2% at 60 and 360 days respectively, and a 5% chance of contact at 360 days in winter.

Table 4-80. Far East Russia-Summer or Winter Fraction of VLOS Contacting an ERA or LS.[1]

Season / Analysis Period	% Range to ERAs ≥0.5%	ERA IDs with any value ≥0.5%
Summer 60 days	1-4	3, 4
Summer 360 days	1-4	3, 4
Winter 360 days	1-4	4
Season / Analysis Period	**% Range to LSs ≥0.5%**	**LS IDs with any value ≥0.5%**
Summer 60 days	1-1	5-8, 22-36
Summer 360 days	1-2	3-8, 21-36
Winter 360 days	1-5	1, 3-10, 12, 15-39
Geographic Name of Land Segments Contacted in Far East Russia: LS1 Mys Blossom, Mys Fomy ; LS3 Mys Florens; LS4 Mys Ushakova, Laguna Drem-Khed; LS5 Mys Evans, Neizvestnaya, Bukhta Pestsonaya; LS6 Ostrov Mushtakova; LS7 Kosa Bruch; LS8 E. Wrangel Island including Klark, Mys Litke, Mys Pillar, Skeletov, Mys Uering; LS9 Mys Proletarskiy; LS10 Bukhta Davidova; LS12 Bukhta Predatel'skaya; LS15 Billings Laguna Adtaynung; LS16 Mys Enmytagyn; LS17 Mys Yakan; LS18 Pil'khikay, Laguna Rypil'khin; LS19 Laguna Kuepil'khin, Leningtadskiy; LS20 Polyarnyy, Pil'gyn; LS21 Laguna Kin-manyakicha, Laguna Pil'khikay, Amen, Pil'khikay, Bukhta Severnaya, Val'korkey; LS22 Rypkarpyy, Mys Shmidta; LS23 Emyem, Tenkergin; LS24 No Name; LS25 Laguna Amguema, Ostrov Leny, Yulinu; LS26 Ekugvaam, Reka Ekugvam, Kepin, Pil'khin; LS27 Laguna Nut, Rigol; LS28 Kamynga, Ostrov Kardkarpko, Kovlyuneskin, Mys Vankarem, Vankarema, Laguna Vankarema; LS29 Akanatkhyrgyn, Nel'teyveyam, Mys Onman, Vel'may; LS30 Laguna Kunergin, Nutepynmyn, Pyngopil'khin, Laguna Pyngopil'khin; LS31 Alyatki, Zaliv Tasytkhin, Kolyuchin Bay; LS32 Mys Dzhenretlen, Eynenekvyk, Lit'khekay-Polar Station; LS33 Neskan, Laguna Neskan, Mys Neskan; LS34 Emelin, Ostrov I dlidlya, I, Memino,Tepken; LS35 Enurmino, Mys Keylu, Netakeniskhvin, Mys Neten; LS36 Mys Chechan, Mys Ikigur, Keniskhvik, Mys Serditse, Kamen; LS37 Chevgtun, Utkan, Mys Volnistyy; LS38 Enmytagyn, Inchoun, Inchoun, Laguna Inchoun, Mitkulino, Uellen, Mys Unikin; 39- Cape Dezhnev, Mys Inchoun, Naukan, Mys Peek, Uelen, Laguna Uelen, Mys Uelen **Name of ERAs Contacted in Far East Russia:** ERA 3 SUA Uelen/Russia, ERA4 SUA Naukan/Russia		

Notes: [1] Fraction of a VLOS (expressed as a percent of trajectories) contacting a certain ERA or LS within 60 or 360 days during summer or winter from any LA.

Appendix A, Tables A.2-28, 30, 34, 36, 54, 60, Maps A-2a, 2b, A-3a LA= Launch Area, ERA = Environmental Resource Area, LS = Land Segment

4.5.11.7. Conclusion

If a VLOS occurred and affected any part of the bowhead or beluga whale migration routes, it could potentially taint this culturally significant resource. Any actual or perceived disruption or tainting of the bowhead or beluga whale harvest from oil spills and any other resulting impacts from a VLOS during the spring migration, summer feeding, and fall migration could disrupt the bowhead hunt for an entire season, even though whales still would be available. Even if whales were available for harvest during the spring and fall hunts, concerns of tainting could make whales less desirable and alter or stop the subsistence harvests in Barrow, Wainwright, Point Lay, and Point Hope, and the beluga whale hunt in Point Lay and Point Hope for at least two seasons. Concerns over cultural practice losses and community health when consuming traditional subsistence foods could persist for many years past any actual harvest disruption. These same concerns would also extend to harvest of walrus, seals, polar bears, fish, and birds. The alteration or cessation of whale hunts and the hunting of other subsistence resources due to contact with oil from a VLOS, actual or perceived tainting, and alterations to subsistence harvests lasting multiple seasons would be a major effect to subsistence-harvesting patterns.

A VLOS occurring on the Leased Area within the Chukchi Sea region could produce effects felt by communities away from the spill. Essentially, concerns about subsistence harvests and subsistence food consumption would be shared by all Iñupiat,Yup'ik, and Chukotka Eskimo communities in the Northwest Arctic Borough, the Bering Strait region, and the Russian Chukokta region adjacent to the migratory corridor used by whales and other migrating species. When a VLOS contacts shoreline, contamination can occur, producing tainting concerns, cleanup disturbance, and disruption of subsistence practices. When these effects are factored together major impacts are expected.

In considering Lease Sale alternatives, LAs 10-11 generally exhibit higher percentages of spills contacting important subsistence areas along the U.S. Chukchi Sea coast. Deferring portions of LAs 10-11 (as proposed under Alternative IV and, to a greater extent, Alternative III) could 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 resource areas.

4.5.12. Sociocultural Systems

Impacts from a VLOS would be expected to impact sociocultural systems to a severe degree. Sociocultural impacts of oil spills can be the result of effects on resources that are used in some way by local residents (i.e., subsistence, tourism, recreation, and elements of quality of life) and the effects of spill-cleanup efforts, in terms of short-term, rapid increases in population and economic opportunities. These effects can cause increased demands on community services and increased stressors to local communities. Potential VLOS effects on subsistence-harvest patterns are analyzed.

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, oil-spill cleanup activities, and resulting stress and reduction in community well-being. If concerns arise over the tainting of bowhead whales and other marine mammals from an oil spill, traditional practices of 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).

4.5.12.1. 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)

Concerns of local communities include being inundated during cleanup with outsiders who disrupt local cultural continuity, damage to the environment, having to engage in oil-spill litigation, and contamination of subsistence foods.

4.5.12.2. Phase 2 (Offshore Oil)

The sociocultural impacts for this phase would blend with and closely resemble those described in Phase 1. The additive stresses produced at this phase would include fears about cleanup response capabilities or a lack of spill cleanup expertise. 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, 1999; Impact Assessment, Inc., 1998; Field et al., 1999; USDOI, MMS, 2003; USDOI, BLM and MMS, 2003).

If offshore subsistence harvest areas were impacted by the spill, or Federal and state response agencies imposed area closures, subsistence harvests could be curtailed or cease completely in these areas and sociocultural systems would be impacted. Stress and fear precipitated by a mistrust of outside governmental institutions could persist long term and would extend far beyond the immediate spill area.

4.5.12.3. 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 possibility of harvesting less preferred resources. Concerns over tainting would create a reluctance to consume traditional resources. The harvest of less-preferred resources is more time, labor, and equipment intensive. See discussions of subsistence resource tainting concerns in Sections 4.3.11 and 4.3.12.

A VLOS would result in the contamination of subsistence resources and would be a threat to the health and way of life of the affected communities. Public health effects are analyzed in Section 4.5.13. If a VLOS affected a traditional harvest use area, subsistence users would have to travel farther to harvest uncontaminated resources, which would result in effects on sociocultural patterns for a much longer time than the period of contamination (USDOI, BLM, 2012).

4.5.12.4. Phase 4 (Spill Response and Cleanup)

Oil-spill employment during response and cleanup could disrupt subsistence harvest activities for at least an entire season or longer. This disruption would affect sociocultural systems by altering harvest patterns and displacement from use areas. Although cleanup activities alone are generally not sufficient to cause displacement, in aggregate, they may create effects that have these effects. Spill cleanup could generate thousands of jobs, and increases in wage employment could have sudden and severe effects, including inflation in the region and displacement of Native residents away from their normal subsistence 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 stressors on local village infrastructure 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, 2012). (See Section 4.5.10 Economy).

4.5.12.5. Phase 5 (Long-term Recovery)

A VLOS can lead to a disruption of social organization, which in turn could lead to decreased emphasis on the importance of the family, cooperation, and sharing. Multiyear disruptions of subsistence-harvest patterns, especially to bowhead whale harvesting, could disrupt sharing networks, subsistence task groups, whaling crew structures, and could cause disruptions of the Iñupiat cultural values of subsistence as a way of life. Disruptions also 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 entrepreneurial activity. 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 health and social services available to community members. Effects on the sociocultural systems described above would be expected to persist for many years, placing additional stress on the sociocultural systems with trends toward sustained displacement of existing institutions (USDOI, MMS, 2007a, USDOI, BOEMRE, 2011a).

Social organization effects would be very pronounced. Social well-being would be affected as health issues, safety concerns, and risk factors would increase. Increased demands would be placed on householder networks, and as available resources were redistributed according to need or food scarcity, 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 depletion of the resources held by the contributing networks. Employment and income effects could be realized as cash was expended to purchase food to make up for the shortfall in harvested foods and to maintain hunting equipment. Workforce changes and demographic changes could occur through consolidation of households to save money, including placement of dependents with relatives beyond the village, outmigration of wage earners in search of employment, and over extension of household credit lines. These effects could deplete the pool of available subsistence producers and would affect the structure of households and reduce the stability of families and communities (USDOI, BLM, 2012).

Stress related to new difficulties when practicing subsistence hunting and community sharing could affect the very 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 these individuals, thus affecting community stability. Over time, if knowledge holders or recipients are removed from the community, spiritual teaching and knowledge transfers that take place during the hunt would be lost. Others in the community who use materials in objects of cultural expression and trade ─ an important source of supplemental income to households ─ could also experience high levels of stress. Individuals and communities would experience increasing stress as they would need to modify subsistence-harvest patterns by selectively changing harvest areas, if such areas were even available. Due to these modifications, there would be increased risks associated with travel and hunting in unfamiliar areas and increasing costs to hunt. Associated cultural activities, such as the Nalukataq celebration and the sharing of subsistence resources, could become modified or decline (USDOI, BLM, 2012).

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 increased costs of food, other expenses such as utilities may 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, 2012).

Research of the long-term effects of the 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:

- 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.
- The level of distress and sense of loss of person and place or “placelessness” would increase with proximity to the spill and the degree of oiling.
- Lingering presence of oil in the environment would lead to continued avoidance of subsistence harvest resources.
- Short-term alteration 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. Concerns about potential sociocultural effects led in many instances to intensification of economic and cultural revitalization as a social movement in communities.
- During cleanup, the effort of village residents would be redirected from subsistence activities to wage-sector employment and redirected between cash/and noncash activities.
- Concerns about contamination of subsistence resources and the safe consumption of these resource would persist with confidence in the benefits of eating natural foods decreasing;
- No major permanent demographic changes would necessarily occur.
- The purchase of lands for conservation areas would cause loss to the Native Alaskan land base, while creating new opportunities for income and investment.

These conditions indicate that a VLOS did cause chronic disruption for a period of time after the Exxon Valdez Oil Spill, but existing social patterns were not permanently displaced. That is, the social structure of villages, towns, and cities, while affected by a VLOS, continued and persisted in the aftermath of the spill (Picou et al., 1992; Cohen, 1993; Picou and Gill, 1993; Fall, 1992; Impact Assessment, Inc., 1990a,b; Fall and Utermohle, 1995; Human Relations Area Files, Inc., 1994a,b,c).

Living in a place-based community, where people's social, cultural and economic lives and livelihoods are carried out in a specific place, means that the losses people experience coincide with the changing landscape (Maldanado, 2014). Impact Assessment, Inc. (2001) conducted a study which added additional consideration of psychological and identity impacts from the Exxon Valdez Oil Spill. Findings emphasized that for Alaskan Natives, the early impacts of the spill were compounded by the sense of “fear” about resource safety, the “alienation” from culturally valued activities, and continuing litigation contributes to continuing psychological impacts of the spill. While this report did not include new data from the 10-year, post spill time period, some of the reported impacts would have been mitigated by the general recovery in subsistence-harvest practices (USDOI, MMS, 2003; 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 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., 1994a,b,c). The summary of findings section indicated that immediately after the spill and continuing into early 1990, Alaska Native people decreased their harvests of wild resources and relied on preserved foods harvested before the spill. By winter 1991, the Alaska 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.” This information was updated earlier in Section 4.5.11 with information from the Exxon Valdez Trustee Council.

New research has identified that directly after an oil spill, fear, community ties, and employment were direct indicators of mental health, physical health, and well-being after an oil spill and that greater community attachment can lower feelings of fear and community disruptions (Cope, 2012).

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, cleanup work produced a redistribution of resources, creating new divisions in communities which resulted in increasing social stresses. Many members of small communities were on the road to sobriety before the spill. After the spill, many 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, the disruption of existing community plans and programs, strain on local officials, difficulty dealing with Exxon, community conflicts, and disruptions of customary habits. There were also changes in communities related to 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., 1994a,b,c; 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, 2012).

4.5.12.6. Oil-spill Trajectory Analysis

The potential impacts to sociocultural systems during each phase of the hypothetical scenario are addressed above. Impacts on sociocultural systems are directly related to impacts on subsistence-harvest patterns (see Section 4.5.11 Subsistence-Harvest Patterns). The oil-spill trajectory analysis for subsistence-harvest patterns and practices applies here for sociocultural systems.

4.5.12.7. Conclusion

The effects of a VLOS on sociocultural systems could cause significant effects via chronic disruption to sociocultural systems for several years, with a tendency for additional stress on these systems. Long-term disruptions to subsistence-harvest patterns and practices would impact sharing networks, subsistence task groups, and crew structures, as well as cause disruptions of the central Iñupiat 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—thus producing 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. (USDOI, MMS, 2003, 2006a, 2007a; USDOI, BLM, 2012; USDOI, BOEMRE, 2011a).

4.5.13. Public Health

Public health indicators and outcomes for communities on the North Slope are analyzed in Section 4.3.13 Public Health. For this analysis, oil spills can be viewed as a public health issue but since operational cleanup practices generally keep the public away from the hazards, it may be considered less important by some during the initial phases of a spill. However, public health deserves discussion and analysis due to its far reaching and long term implications on human populations in the spill zone region (NRC, 2003a). There are many factors that efffect public health issues and trends, along with public perceptions regarding health risks from oil spills and dispersants. Oils spills and cleanup measures, especially the use of dispersants, have become more widely reported in the media, reports, and journals, thus increasing community fear and varying perceptions regarding spill events (Belter, 2013). The Agency for Toxic Substances and Diseases Registry (ATSDR) Regional Response Team (RRT) representative is a Federal health resource that routinely supports public health officials in assessing health risks and facilitating collaborative local community meetings to actively manage health risk perceptions during oil spills.

The overarching effects of an oil spill on public health are varied. Primary health indicators during an oil spill are mental health, food security and safety, and exposure to environmental contaminants. Outcomes from these risks can be acute (changes in the environment resulting in immediate stress) and chronic (loss of subsistence foods resulting in long-term nutritional deficits). Greiner et al. (2013) describes some shortfalls in managing public health and risk perceptions going beyond the familiarity of baseline health status and developing adaptive strategies to manage health risks, indicators, and outcomes post spill and long-term. This adaptation to risks could promote community resilience in subsistence communities, and help mitigate related psychosocial and physiological impacts.

As the acute phase of an oil spill transitions to a chronic phase, this transition is marked by long-term challenges to the public health. Rendler (2014) found, after the DWH event, evidence of significant and potentially lasting impacts of the disaster occurred and affected the physical health, mental health, and economic fortunes of residents and their children and on the way they live their day-to-day lives. Mental health effects, which could be expected to be one of the first community health issues after a spill, have shown, after DWH, that communities who were 'indirectly impacted,' as opposed to being directly oiled from the spill, displayed clinically significant levels of anxiety and depression. This finding of high stress in communities directly and indirectly impacted by the spill can lead to the conclusion that a loss of culture, lifestyle, and income from the spill had a greater impact on psychological health than exposure to the oil itself.

Lee and Blanchard (2012) and Shepro and Maas (2006) found that strong community attachment can cause stress in the event of a technological disaster and they concluded that high levels of attachment tend to generate worry about community well-being and threats to that well-being. They also suggest that social interaction associated with community attachment fosters negative affect and stress. Research findings from the DWH event have identified the emergence of a variety of negative sociocultural and psychosocial impacts across the northern Gulf of Mexico following the BP spill (Gill et al., 2013). This growing body of literature related to oil spills and resulting effects, highlights the importance of considering multiple types of predictors (oil related, community related, trust associated) for identifying the sources of psychological stress produced by massive oil spills. These effects could be similar for Iñupiat communities in Alaska. These communities are "place" based and many individuals have strong community attachments as well as significant cultural attachments. Hence, oil spills disrupting the mental health and well-being of a community would result in long term impacts to overall health.

A VLOS would affect the environment of the North Slope and cause health effects in Alaska Native communities, a recognized minority. With a VLOS, any health impacts could trigger environmental justice issues, which is analyzed in Section 4.5.14. A VLOS would be anticipated to exacerbate health outcomes including: (1) stressors associated with sociocultural change (loss of subsistence-harvest practices), (2) changes in environmental quality, (3) changes in health pathologies (mental health issues, altered nutritional status); (4) increasing social pathologies (alcohol and drug misuse, domestic violence, suicide), and (5) changes in personal economics. Collectively, these social determinants of health encompass the array of sociocultural factors resulting in specific health outcomes (Section 4.5.13 Public Health).

Both on- and offshore oil and gas development on the North Slope have both direct and indirect influences on community health. These influences may include: acculturation (the influx of people from a different culture entering previously isolated Iñupiat villages, stress over actual or perceived threats to culture and subsistence; direct and indirect employment opportunities; and broad economic and infrastructure improvements. Changes brought by oil and gas development, and analyzed in this VLOS scenario, assume a spill may create local (village-level), regional, statewide, and even possibly national effects. Furthermore, social determinants of health may create both positive and negative effects on health status. Local and regional effects may be the most important to recognize and could lead to more effective strategies for mitigation (Draper et al., 2010; Assai et al., 2006). For example, local increase in employment may create both benefits through economic opportunity or effects due to tensions between the internal conflict of providing for one's family through subsistence activities and the pressure as a wage earner. Mitigation measures to decrease stressors and to maintain health and nutritional status could be realized by devising flexible work schedules to allow participation in both activities. A VLOS event would impinge on and influence all the factors mentioned above.

If a VLOS occurred and contaminated essential whaling areas, major effects could occur when subsistence species or shorelines become contaminated. Tainting of resources used for subsistence can result in a disruption of subsistence food gathering and is a serious concern to Alaska Natives regarding their health. These indicators and outcomes further demonstrate that to have a vital, productive life, subsistence, at a minimum, is a basic physiologic and psychological need which must be met (Poppel et al., 2007; Hicks and Bjerregaard, 2006; Shepard and Rode, 1996; Maslow, 1954). However, using this model, the ability to subsistence hunt and to provide for one's community and family in not only imperative culturally, it can increase well-being and allow hunters and those who are part of the community structure, assisting after hunts, to attain greater feelings of love and belonging, self-esteem, and the realization of one's full potential as a provider. This again, improves individual and community well-being and psychosocial health outcomes.

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 health effects, and should be considered a major health effect of a VLOS if individuals or communities are exposed (see Section 3.3.4).

Anyone dependent on subsistence-harvest patterns 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, evacuating people from the contaminated area, and having residents avoid 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, sharing these results with the community. 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 (FDA) 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 (ADF&G, 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 impacts to public health.

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 enough to convince 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).

4.5.13.1. Phase 1 (Initial Event)

The location of a hypothetical blowout would occur, at the closest, 60 miles or more from the shore. After the blowout, an ensuing fire may occur, but the initial event is not expected to impact land resources immediately. The smoke plume from the ensuing fire presents human health and environmental toxicity risks posed by the emissions. Health impacts, such as exacerbations of asthma or other respiratory disease, could result from this release of air emissions and odors can cause acute symptoms such as nausea, headaches, along with eye, nose and throat irritation. Further, pre-existing stress resulting from fear of a VLOS and potential effects of a blowout on subsistence-harvest patterns, now realized, would occur.

4.5.13.2. Phase 2 (Offshore Oil)

Public health impacts during this phase would relate closely to those described in Phase 1 and 2 of Sections 4.5.11 Subsistence-Harvest Patterns and 4.5.12 Sociocultural Systems. If a blowout occurred offshore, community stressors would increase and if subsistence resource migration areas or subsistence harvest areas were impacted by the spill, subsistence foods could be perceived as tainted and harvests could be curtailed or cease completely in these areas. A VLOS would increase stress and if traditional subsistence activities were curtailed, this would affect the short-term and eventually long-term public health of Iñupiat Natives.

4.5.13.3. Phase 3 (Onshore Contact)

Public health impacts reported in other oil spill events during the initial period of exposure have included symptoms of irritation to the eyes, skin, and lungs. If a VLOS occurred in or reached a traditional harvest use area, subsistence hunters would travel farther to harvest uncontaminated resources. This alteration in harvest patterns could result in increased safety risks during harvesting which could affect health. These risks include the potential for accidents, injury and even death. However, for long-term, individual health, there can be positives to working harder and traveling farther for hunting. Since harvesting of wildlife resources takes considerable physical exertion, this contributes to better physical and mental well-being for individuals. Lack of traditional foods in the daily diet has been linked to diet changes with increased morbidity and mortality (e.g., diabetes and heart disease). Further, reductions in overall caloric input from subsistence foods have been documented to have negative impacts on the physical and mental health of Arctic indigenous communities (Wernham 2007). These increases in illness are linked with increased medical care costs, creating another stressor due to personal economics. Health effects from onshore contact would be long-term and manifest in many outcomes.

4.5.13.4. Phase 4 (Spill Response and Cleanup)

A VLOS in the Chukchi Sea would trigger a wide-scale spill response and cleanup effort. As illustrated by the Exxon Valdez Oil Spill, this Phase could affect public and community health in several ways. Oil-spill cleanup workers and communities impacted by oil spills have shown increases in mental health outcomes due to the psychosocial and physical stressors from the initial spill event (Kwok et al., 2012). Stressors from oil-spill cleanup include exposures to oil and dispersants, income uncertainties, and challenges of family and community disruption. In North Slope communities, positive outcomes may be realized by local residents having more paid employment during cleanup efforts. A drawback to wage employment is the limiting of participation in subsistence activities. If subsistence resources are actually or perceived to be tainted this too can alter normal subsistence practices. Given the urgency of cleanup effort activities, this could draw local workers away from village service jobs, which tend to be lower paying. Increased employment and income have been shown to be associated with positive health outcomes.

A rapid influx of nonresident personnel to a community is likely, and could lead to increased social and psychological problems. 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 changes become as they related to social upheaval and implications for health (Human Relations Area Files, Inc., 1995; ADF&G, 1995b; Impact Assessment, Inc., 1990a,b, 1998). Impacts of this population influx can create short-term and unstable employment increases, risk of infectious disease transmission, compromises to the efficacy of local prohibition laws in preventing health effects from alcohol consumption, and exacerbation of social and psychological strain which leads to maladaptive behavior, including violence and alcohol and drug misuse. The 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 and cardiovascular disease. These health impacts could be acute or chronic in nature as long as oil-spill response occurred, and would likely be long-term, resulting in public and community health impacts.

4.5.13.5. Phase 5 (Long-term Recovery)

In the event of a VLOS, considerable stress and anxiety would occur over the loss of subsistence-harvest patterns, contamination of habitat, and fear of the health effects of eating contaminated wild foods, fear of changes to harvest regulations (e.g., whale strike quotas), and the need to depend on the knowledge of others about environmental contamination (Fall, 1992; McMullen, 1993). Reductions and displacement of subsistence resource populations and fear of contamination could combine to substantially reduce traditional subsistence food consumption. If this reduction in ‘wild’ food consumption occurred, the prevalence of cardiovascular diseases, cerebrovascular disease, and metabolic disease such as diabetes would be expected to increase substantially and increases in contaminant-related health problems such as cancers, respiratory disease, birth defects, and chemical exposures could also be expected. With a decrease of subsistence-harvest patterns, food insecurity would increase markedly, and unless sharing networks and government programs were able to respond rapidly, hunger, nutritional deficits, and potentially (though less likely) malnutrition could result (USDOI, BLM, 2012)(also see Section 3.3.4).

Social pathologies would likely increase, and, with increased social pathology injury rates, mortality and morbidity rates 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). Impacts resulting from increasing public and community health burdens included additional burdens on local government services, strain on local officials and residents, community conflict, disruptions of habits and behaviors, and stress-related disorders. Post-spill stress resulted from the perception of a loss of control over individual lifestyles creating uncertainty and community segmentation (Smythe, 1990).

Another concern is related to long-term health impacts to cleanup workers as stated in Phase 4: research conducted by Kwok (2014) found that persons who worked on oil-spill cleanup were more likely to report mental health outcomes than those who did not. The 2013 Gulf Long Term Follow-Up Study (GuLF Study), being conducted by the National Institute of Environmental Health Sciences (NIEHS) has been, since 2011, following 32,716 participants (26,432 males and 6,284 females) and examining how different aspects of oil-spill cleanup may affect current and future health. The study is examining how stress and job loss due to the DWH oil spill affects health, including mental health. It is comparing workers doing specific cleanup jobs to others who did not do those same jobs, in an attempt to learn if health problems are occurring at a higher rate than expected among some groups of workers.

Long-term recovery from oil spills has been shown to have impacts on individuals, families, and communities. During this recovery period, adults may experience symptoms of depression, anxiety, and post-traumatic stress, often compounded by substance abuse and economic hardship resulting in physiological disease. Young children are more likely to show regression and dysregulation (impairment of immune response and organ function) and adolescents are more likely to exhibit behavioral and mental health problems and gender-specific responses (gender is a critical determinant of mental health and illness and determines the differential power and control men and women have over the socioeconomic determinants of their mental health and lives, their social position, status and treatment in society and their susceptibility and exposure to specific mental health risks) (WHO, 2014; Osofsky, 2014).

4.5.13.6. Oil-spill Trajectory Analysis

The potential impacts to public health during each phase of the VLOS event are addressed above in Section 4.5.11 Subsistence-Harvest Patterns. Oil-spill effects and their impacts on subsistence-harvest patterns and sociocultural systems directly correlate with effects on public and community health analyzed in Sections 4.5.11 Subsistence-Harvest Patterns and 4.5.12 Sociocultural Systems. The effects described in these sections would be experienced here and affect the public health of the Iñupiat populations of the North Slope.

4.5.13.7. Conclusion

Public health impacts from a VLOS would come from various media: ground or surface water, sediment, soil, air, and for many communities, animals and plants. Animal and plant resources are important because they are key elements used for subsistence, the lynchpin of the sociocultural milieu and the cultural foundation in these communities. These resources also are important in maintaining good health in the NSB as they add to a healthy nutritional status for those in the community by providing a traditional diet. Human exposure to contaminants from an oil spill may be caused by contact via inhalation, skin contact, or ingestion of contaminated subsistence foods. Reduced availability or acceptability of subsistence resources, periodic interference with subsistence-harvest patterns from oil spills and cleanup, and stressors resulting from fear of an oil spill may affect public and community health.

It is possible to minimize or mitigate effects to public or community health. In most cases, mitigation measures aim to reduce the vulnerability of the population and in some cases attempt to reduce the magnitude of the hazard. In any case, the vulnerability would be brought to the lowest level possible and attempt to reduce medical casualties by improving the structural quality of the environment. With a VLOS, services to the community may be interrupted, jeopardizing the health of the population. Subsistence resources and water supplies may be contaminated, increasing risk to public health. In addition, the loss of subsistence harvests and the subsequent social costs of such loss can severely strain communities of the North Slope (WHO, 2000). Therefore, effects from a VLOS, considering mitigation potentials, would be moderate.

Selection of Lease Sale alternatives that incorporate both deferral corridors (Alternative III and IV) along the Chukchi Sea could reduce the potential for drilling in areas closer to the shoreline. To the extent that hypothetical spill from areas within these deferral corridors exhibit higher percentages of trajectories contacting with shorelines or other areas important to subsistence harvest, selection of either Alternative III or IV could slightly reduce the potential for VLOS impacts. Alternative III, the larger deferral area, is most likely to reduce the impacts since it incorporates the largest deferral area.

4.5.14. Environmental Justice

Any significant impacts to subsistence-harvest patterns and harvests or sociocultural systems from a VLOS would represent environmental justice impacts, potentially having disproportionate, high, adverse environmental health effects, and positive economic effects on low-income, minority populations in the region. Alaska Iñupiat Natives, a recognized minority, are the predominant residents of Chukchi Sea coastal communities in the NSB and the 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. Indigenous populations are the predominant residents of the Bering Strait region as well as the Russian Chukotka region. For this discussion, the Russian Chukotka region will not be analyzed under EJ 12898, an Executive Order originating in the United States.

The Russian Chukotka region is not addressed under EJ 12898 here; however, it is important to note that Chukotka people are attempting to establish their own form of indigenous basic rights grounded in the foundation that northern affairs must be administered by those living in the region. The Native associations in the Far East have expressed the following goals for Native People (Clay, 1994; Programma Assotsiatsii Korennyk> Zhitelei poselenii Oli, 1990):

- Native peoples must have control of traditional economies: hunting, herding, and fishing. Indigenous land use for hunting and herding must have priority over industrial activities, which themselves must be halted until agreements can be reached over control of resources and until environmentally sound practices can be implemented
- Native peoples must have political rights: fair representation at all levels of government

- The spiritual development and rebirth of native cultures depends on the strengthening of national languages, culturally appropriate education and employment afterwards, the revival of ancient rituals and ceremonies, etc.
- The physical survival of Native people is at critically low points and adequate health care must be a priority

EJ analysis, as it relates to the Executive Office's charge to examine "human health and environmental effects on minority populations and low income populations" is a discussion of human health outcomes that arise from the baseline health indicators of indigenous populations on the North Slope and in the Northwest Arctic Borough. A VLOS would exacerbate some indicators including: existing regional health pathologies; social pathology (assault, alcohol and drug abuse, domestic violence, suicide, and homicide); major employment fluctuations; major changes in economic development; stresses associated with sociocultural change (acculturation, an influx of oil-spill remediation workers, increases in the economic standard of living, changes in education, etc.); and changes in environmental quality. Collectively, these health indicators encompass the array of socioeconomic and environmental factors and have effects on specific health outcomes which can cause disproportionally high adverse effects on these communities. For a more in-depth discussion of these factors, see Section 4.3.14 Environmental Justice.

State onshore and offshore oil and gas development has become a dominant socioeconomic force on the North Slope. Effects of this development has resulted in acculturative pressures, stress over perceived and actual threats to culture and subsistence, increasing wage employment opportunities, and increasing economic and infrastructure improvements. However, many of these effects have also improved health outcomes in NSB communities. The potential changes brought by oil and gas development the VLOS scenario assumes may create statewide, regional, and local effects. Recognition of local and regional health effects may lead to more effective strategies for health outcome mitigation (Assai et al., 2006).

In the event of a VLOS, many of the impacts associated with routine oil and gas activities as they relate to EJ could intensify. Subsistence-harvest patterns, sociocultural systems, and human health could all be affected. Iñupiat Natives are susceptible to effects from oil and gas activities due to their reliance on subsistence hunting and cultural significance of these foods. Potential effects would occur to the Iñupiat communities near the Leased Area: Barrow, Wainwright, Point Lay, and Point Hope. Other subsistence communities, including those in the NWAB, the Bering Strait and along the Russian Chukchi Sea would also be affected. If a VLOS occurred and contaminated essential whale migration areas or whale hunting areas, major effects could occur when the following effects are factored together: actual or perceived contamination and tainting, cleanup disturbance, and the resulting disruption of subsistence practices. In general, the central issue of effects on subsistence will be used as a baseline measurement for potential EJ impacts.

As analyzed in Section 4.5.12, sociocultural impacts of a VLOS on Alaska Native communities are interconnected with the subsistence way of life of these communities. Subsistence embodies traditions of Alaska Native cultures with overlapping connections to other cultural, social, and economic institutions. Some effects may also be felt beyond the localized villages. Given the extensive subsistence-food-distribution networks that extend to family and community members living in other places, a disruption of harvesting, processing, and sharing can affect connections between these sharing networks. Given the importance of subsistence-harvest patterns to the NSB and surrounding Iñupiat populations, all defined as minority populations, major impacts to subsistence-harvest patterns affecting Alaska Native sociocultural systems due to disproportionate, high adverse impacts would result in environmental justice issues. Many of the North Slope Communities actively work to preserve the traditional values of Alaska's indigenous peoples and communities facing environmental injustice. They are incorporating programs to integrate EJ into the front end of development by or the meaningful participation of impacted communities in government to government decision-making, working with communities and tribes to mitigate environmental damages before they occur and by advocating for independent industry oversight with stronger policies on human health.

It is important to make connections between cultural, social, health and economic issues when conducting EJ analysis as it relates to oil and gas development. Oil-spill contamination of subsistence foods, actual or perceived, is a serious concern since traditional foods are 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 physical 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 affect actual or perceived food security, nutritional status, and the risk of nutritionally-based chronic medical problems as described in Section 3.3.4. Effects of contaminant-related health effects related to an oil spill are being studied more since the DWH event in the Gulf of Mexico. Using contaminants with well-characterized toxicological profiles such as benzene and specific PAHs, exposure known to produce adverse health effects should be considered as a health effector from a VLOS if individuals or communities are exposed to these contaminants (see Section 3.34).

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, evacuations, and avoiding marine and terrestrial foods that may be affected. Federal and state agencies with health-care responsibilities would have to sample food sources testing for possible contamination. Interestingly, after historical testing of subsistence foods for hydrocarbon contamination (from spills between 1989-1994) revealed very low concentrations of petroleum hydrocarbons in most subsistence foods, the U.S. Food and Drug Administration (FDA) 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 has a higher potential of hydrocarbon accumulation.

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 past oil-spill studies, Alaska 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 still remains 25 years later, in Alaska Native communities in Prince William Sound. However, even though fears about food safety have diminished since the spill, it is still a concern for some users today though harvest levels from villages in the spill area are now comparable to other Alaskan communities. It is for these reasons that the subsistence is considered to be recovering from the effects of the Exxon Valdez Oil Spill (EVOSTC, 2014). 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 Exxon Valdez Oil Spill, analytical testing and rigorous reporting procedures to get results out to local subsistence users never completely convinced many subsistence users about the safety of their food. Scientific conclusions often were not consistent with Native perceptions about environmental health. A mitigation measure to this effect as it relates to EJ is, according to Peacock and Field (1999), a discussion of subsistence-food contamination issues reflecting an interdisciplinary approach from toxicologists, marine biologists, and cultural anthropologists. This discussion must include cross-cultural communications leading to an understanding of cultural perceptions and definitions related to the community’s risk perception of traditional foods and the environment. Discussions of subsistence-resource contamination must understand conflicts between eurocentric science and traditional knowledge (Deloria, 2001). 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." Since 1995, subsistence restoration resulting from the Exxon Valdez Oil Spill has improved by taking a more comprehensive approach, partnering with local communities and linking scientific research with traditional knowledge (Fall et al., 1999; Fall and Utermohle, 1999; USDOI, MMS, 2007a).

With regard to seafood safety, a common-sense tendency among subsistence practitioners to avoid any areas and foods that may have been affected by spilled oil is practiced. In the case of the *Selendang Ayu* spill in 2004, the freighter ran aground, spilling 321,052 gallons of viscous fuel and 14,680 gallons of diesel and other fuels. Although the state-sponsored subsistence foods testing program revealed no carcinogenic threat from the PAHs in the oiled areas, key community members reported lingering uncertainty and reluctance to use marine resources from certain areas affected not only by the the *Selendang Ayu* spill but also by the M/V *Kuroshima* spill, which occurred in 1997 (Impact Assessment, Inc. , 2011a).

4.5.14.1. Phase 1 (Initial Event)

Given the location of a hypothetical blowout more than 55 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. A potential EJ effect could be pre-existing stress created by fears of a VLOS, now realized, which could be triggered. Such stress could be interpreted to be a disproportionate impact on the local Iñupiat population (Section 4.5.12 Sociocultural Systems).

Effects from a spill originating within the Chukchi Sea region could be felt by communities remote from the Leased 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 Sea (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.

4.5.14.2. Phase 2 (Offshore Oil)

Environmental justice impacts during this phase would closely resemble those described in Phase 1. Again, impacts described in Sections 4.5.11 Subsistence-Harvest Patterns, 4.5.12 Sociocultural Systems, and 4.5.12 Public Health are relevant here. If offshore subsistence harvest areas were impacted by the spill, subsistence harvests could be curtailed or stop completely in these areas and subsequent 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 Alaska Iñupiat Natives, a defined minority population.

4.5.14.3. Phase 3 (Onshore Contact)

To the extent that a VLOS affected local subsistence-harvest patterns, cultural practices, and sociocultural resources effects on environmental justice would be expected. Contamination of subsistence resources would pose a threat to the health and way of life of the affected communities. Consumption of contaminated resources would likely lead to increases in some contaminant-related health problems. In the short term, these problems might be minimized by avoiding areas of contamination and the consumption of subsistence resources, but chronic, persistent low-level contamination many years after the spill could cause long-term health problems (USDOI, BLM, 2012; USDOI, BOEMRE, 2011a). If a VLOS occurred in or reached a traditional-use area, subsistence users would also have to travel farther to harvest uncontaminated resources and alterations in harvest patterns could result in increased safety risks during harvesting thus causing a major effect on EJ. The onshore contact phase poses a higher impact and the resulting potential for disproportionate, high adverse impacts on EJ.

4.5.14.4. Phase 4 (Spill Response and Cleanup)

A VLOS in the Chukchi Sea would trigger a wide-scale spill response and cleanup effort. As illustrated during the Exxon Valdez Oil Spill, this Phase could implicate environmental justice considerations in several ways. First, wage employment of local residents in cleanup efforts could alter participation in subsistence activities, altering normal subsistence practices. Given the urgency of cleanup activities, this could draw local workers away from village service jobs, which tend to be lower paying. However, increased employment and income are generally associated with positive health outcomes.

Second, rapid in-migration of nonresident personnel to a community is likely, leading to increased social and psychological problems. Adverse effects could occur due to negative social or economic interactions with non-residents. In general, the larger the spill, the more dramatic changes are as they relate to social upheaval and implications for health (Human Relations Area Files, Inc., 1995; ADF&G, 1995b; Impact Assessment, Inc., 1990a,b, 1998). Social and psychological strain leading to maladaptive behavior, including violence or alcohol and drug misuse may arise from rapid increases in cash-flow, the in-migration of nonresident workers to communities, and short-term or unstable employment. Interference with subsistence seasonal activities would have implications for nutritional health and chronic disease. Such impacts could continue as long as oil-spill-response activities occur having lingering environmental justice impacts.

Harsh weather conditions, and movement of pack ice in the Chukchi Sea, and the lack of extensive onshore infrastructure would present novel challenges for oil-spill cleanup which could increase the risk of public health and safety problems resulting from exposure to contaminants, perceived risks of subsistence resource contamination, and potential accidents for community members hired to conduct spill cleanup activities. If Federal and State response agencies close affected areas to harvest, additional impacts to subsistence could occur due to the inability to access traditional hunting use areas.

4.5.14.5. Phase 5 (Long-term Recovery)

In the event of a VLOS, considerable stress and anxiety would occur over the loss of subsistence-harvest patterns, contamination of habitat and subsistence resources, fear of the health effects of eating contaminated wild foods, fear of changes to harvest regulations (e.g., whale strike quotas), and the need to depend on knowledge of others about environmental contamination (Fall, 1992, McMullen, 1993). Reductions and displacement of subsistence resource populations and fear of resource contamination could combine to substantially reduce subsistence resource consumption. If this occurs, the prevalence of some health disorders would be expected to increase substantially and increases in contaminant-related health problems could also be expected. Food insecurity would increase markedly, and unless sharing networks and government programs were able to respond rapidly, hunger and potentially malnutrition could result (USDOI, BLM, 2012; USDOI, BOEMRE, 2011a).

Social pathology would likely increase, and, with increased social pathology and more difficult hunting conditions, injury rates, mortality, and morbidity could also increase. For example, 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 (child abuse, domestic violence, and accidents). Post-spill stress resulted from the seeming loss of control over environments and uncertainty over outcomes, and community segmentation (Smythe, 1990).

Effects on health determinants and impacts on health outcomes after a VLOS are some of the most serious EJ issues after such a catastrophic event. If disruptions to the food sharing networks and increasing social pathologies are extensive and persistent, there can be long-term effects of both physiological and psychosocial health (Ritchie and Gill, 2004; Marmot and Wilkinson, 2004; USDOI, BLM, 2012).

4.5.14.6. Oil-spill Trajectory Analysis

The potential impacts to environmental justice during each phase of the VLOS event, in terms of oil-spill trajectory analysis, would have impacts on subsistence, sociocultural systems, and public health which directly affect EJ (Section 4.5.11 Subsistence-Harvest Patterns, 4.5.12 Sociocultural Systems, 4.5.13 Public Health). The effects described in these sections would be experienced primarily and have the most impacts to, the subsistence-dependent minority Iñupiat population.

4.5.14.7. Conclusion – Effects of a VLOS

As explained above, due to the loss of subsistence-harvest patterns, changes to sociocultural systems and effects to public and community health, effects to EJ would be felt after a VLOS.

Environmental Justice Impacts on Iñupiat populations would occur due to their reliance on subsistence foods, and the effects of an oil spill would impact subsistence-harvest patterns, harvest practices, sociocultural systems, and human health. Trajectories during a VLOS event would have effects on Iñupiat communities of the NSB residing in Barrow, Wainwright, Point Lay, and Point Hope. These communities and their residents would experience adverse impacts resulting in long-term impacts to EJ. Subsistence communities of the NWAB, the Bering Strait region, and the Russian Chukchi Sea coast would experience similar adverse impacts to varying degrees whether effects are direct or indirect.

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 spill 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, the larger deferral corridor, could slightly reduce the potential for VLOS impacts.

The majority of subsistence resources affected are anticipated to recover over the long term as evidenced by the Exxon Valdez and the Selendany Ayu oil spills. Any long-term reductions in subsistence resources, causing the inability to hunt and gather these resources would exacerbate disruptions to subsistence harvests; displace sociocultural systems, and affect public health, resulting in EJ impacts. There would be lasting effects on sociocultural institutions resulting from an existing shorebase and field crews residing in the area, conducting maintenance for onshore pipeline route. This could result in long-lasting psychosocial effects from acculturation. There could also be impacts from oil-spill intervention, response and cleanup efforts and certain environmental effects. The most significant and perhaps irrevocable adverse impact associated with a VLOS event would be the overall loss of a cultural foundation piece (subsistence hunting) and the loss of basic foods necessary to survive day to day (subsistence foods). The loss of resources and its effect on the interconnectedness of cultural practices and institutions, health and well-being would result in disproportionate, high, adverse environmental, health, and economic effects on Native Iñupiat populations causing significant EJ impacts.

In the event of a VLOS in the Chukchi Sea, EJ-related impacts described above would produce disproportionate, high, adverse effects in the Iñupiat communities of the NSB, the NWAB, and the Bering Strait communities and in communities along the Russian Chukchi Sea coastline. Therefore, effects of a VLOS on EJ would be major.

4.5.15. 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 affected. Protection of archaeological resources during an oil spill may not be achievable in many instances because to do so requires specific knowledge of the resource's location, condition, nature, and extent prior to impact and large portions of the coastline have not been systematically surveyed for archaeological sites. Even so, every land segment but one along the Alaskan Chukchi Sea coastline contains a known or reported archaeological or historic resource. 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.

As described in Section 4.3.15.2, 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:

- BOEM Handbook 620.1H, Archaeological Resource Protection
- BSEE 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.
- BOEM 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
- The Archeological Resource Protection Act of 1979 (ARPA), as amended

Historic properties, including onshore and offshore archaeological resources, would be identified before any proposed activities are permitted, and they would be avoided, or potential effects mitigated.

After the Exxon Valdez Oil Spill (EVOS), 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, 2012). This analysis assumes that significant effects occur whenever unique archaeological information is lost.

4.5.15.1. Phase 1 (Initial Event)

Onshore archaeological resources (prehistoric and historic sites) would not be immediately impacted during the initial phase of a VLOS because the distance of a blowout site from shore would be at least 60 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, 2011a). 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 archaeological 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 anomalies such as shipwrecks and other geomorphical features. In the past, BOEM 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, 2011a). 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 the 2011 SEIS 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.

4.5.15.2. 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, 2011a). 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, 2011a).

4.5.15.3. Phase 3 (Onshore Contact)

A VLOS would affect onshore archaeological sites the most. In the event of a VLOS scenario, it is estimated that hundreds, if not thousands, of miles of discontinuous Alaskan and Russian 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 VLOS 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, 2011a).

4.5.15.4. Phase 4 (Spill Response and Cleanup)

Various aspects of a VLOS response and cleanup have some potential to affect archaeological resources.

Offshore archaeological resources could be disturbed by vessel anchoring, though damages from vessels associated with oil-spill-response activities such as 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 size of anchors and the length of mooring chains needed to safely secure vessels. Additionally, as seen for the Deepwater Horizon (DWH) event, multiple offshore vessel decontamination stations would likely be established in shallow water outside of ports or entrances to inland waterways. 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, 2011a).

It is possible that large quantities of subsea dispersants could be used during spill response. This could result in 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, 2011a).

The potential for damage to 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 explained above, this could result in increased degradation of wooden shipwrecks and artifacts (USDOI, BOEMRE, 2011a).

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 cleanup procedures would create even greater impacts. Since cultural resources are nonrewable, the effects could result in loss of site integrity (USDOI, MMS, 2007a, 2009; USDOI, BLM, 2012).

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, 2012).

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 cleanup activities (USDOI, BOEMRE, 2011a). 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).

4.5.15.5. Phase 5 (Long-term Recovery)

Unlike biological resources that have the potential to recover, damage to archaeological resources from a VLOS and its cleanup activities would be irreversible, leading to the loss of important archaeological data needed for proper study and interpretation (USDOI, BOEMRE, 2011a). Long-term effects of oiling on prehistoric and historic archaeological resources are difficult to predict, although 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.

4.5.15.6. Oil-spill Trajectory Analysis

It is difficult to prioritize any areas of the Chukchi Sea and coastline as more important for archaeological resources, because cultural resources documented in the Alaska Heritage Resource File (AHRS, 2014) are found in nearly all of the land segments from the Canadian Border to just south of Point Hope (LSs 111-40), 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 (Tables 4-81 and 4-82) shows portions of Wrangel Island, the Chukotka Peninsula and the North Slope coastline from Point Hope to Barrow have some percentage of trajectories contacting individual LSs within 60 or 360 days during summer or winter. The percent of trajectories contacting LSs from a VLOS has the potential to be widespread.

Table 4-81. Far East Russia-Summer or Winter Fraction of VLOS Contacting a Certain LS.[1]

Season / Analysis Period	% Range to LSs ≥0.5%	LS IDs with any value ≥0.5%
Summer 60 days	1-1	5-8, 22-36
Summer 360 days	1-2	3-8, 21-36
Winter 360 days	1-5	1, 3-10, 12, 15-39
Geographic Name of Land Segments Contacted in Far East Russia: LS1 Mys Blossom, Mys Fomy ; LS3 Mys Florens; LS4 Mys Ushakova, Laguna Drem-Khed; LS5 Mys Evans, Neizvestnaya, Bukhta Pestsonaya; LS6 Ostrov Mushtakova; LS7 Kosa Bruch; LS8 E. Wrangel Island including Klark, Mys Litke, Mys Pillar, Skeletov, Mys Uering; LS9 Mys Proletarskiy; LS10 Bukhta Davidova; LS12 Bukhta Predatel'skaya; LS15 Billings Laguna Adtaynung; LS16 Mys Enmytagyn; LS17 Mys Yakan; LS18 Pil'khikay, Laguna Rypil'khin; LS19 Laguna Kuepil'khin, Leningtadskiy; LS20 Polyarnyy, Pil'gyn; LS21 Laguna Kin-manyakicha, Laguna Pil'khikay, Amen, Pil'khikay, Bukhta Severnaya, Val'korkey; LS22 Rypkarpyy, Mys Shmidta; LS23 Emyem, Tenkergin; LS24 No Name; LS25 Laguna Amguema, Ostrov Leny, Yulinu; LS26 Ekugvaam, Reka Ekugvam, Kepin, Pil'khin; LS27 Laguna Nut, Rigol; LS28 Kamynga, Ostrov Kardkarpko, Kovlyuneskin, Mys Vankarem, Vankarema, Laguna Vankarema; LS29 Akanatkhyrgyn, Nel'teyveyam, Mys Onman, Vel'may; LS30 Laguna Kunergin, Nutepynmyn, Pyngopil'khin, Laguna Pyngopil'khin; LS31 Alyatki, Zaliv Tasytkhin, Kolyuchin Bay; LS32 Mys Dzhenretlen, Eynenekvyk, Lit'khekay-Polar Station; LS33 Neskan, Laguna Neskan, Mys Neskan; LS34 Emelin, Ostrov I dlidlya, I, Memino,Tepken; LS35 Enurmino, Mys Keylu, Netakeniskhvin, Mys Neten; LS36 Mys Chechan, Mys Ikigur, Keniskhvik, Mys Serditse, Kamen; LS37 Chevgtun, Utkan, Mys Volnistyy; LS38 Enmytagyn, Inchoun, Inchoun, Laguna Inchoun, Mitkulino, Uellen, Mys Unikin; 39- Cape Dezhnev, Mys Inchoun, Naukan, Mys Peek, Uelen, Laguna Uelen, Mys Uelen		

Notes: [1] Fraction of a VLOS (expressed as a percent of trajectories) Contacting a Certain LS Within 60 or 360 Days During Summer or Winter From Any LA.

Appendix A, Tables A.2-34, 36, 60, Map A-3a, LA= Launch Area, LS = Land Segment

Table 4-82. U.S. Alaska-Summer or Winter Fraction of VLOS Contacting a Certain LS.[1]

Season / Analysis Period	% Range to LSs ≥0.5%	LS IDs with any value ≥0.5%
Summer 60 days	1-4 except LS85 2-6	64-66, 71-85
Summer 360 days	1-4 except LS85 2- 7	64-66, 71-85
Winter360 days	1-2	64-66, 74-76, 83-85
Geographic Name of Land Segments Contacted in Alaska: LS64 Aiautak Lagoon, Ipiutak Lagoon, Kowtuk Point, Kukpuk River, Pingu Bluff, Point Hope, Sinigrok Point, Sinuk; LS65 Buckland, Cape Dyer, Cape Lewis, Cape Lisburne; LS66 Ayugatak Lagoon; LS71 Kukpowruk River, Naokok, Naokok Pass, Sitkok Point; LS72 Epizetka River, Kokolik River, Point Lay, Siksrikpak Point; LS73 Akunik Pass, Tungaich Point, Tungak Creek; LS74 Kasegaluk Lagoon, Solivik Island, Utukok River; LS75 Akeonik, Icy Cape, Icy Cape Pass; LS76 Akoliakatat Pass, Avak Inlet, Tunalik River; LS77 Mitliktavik, Nivat Point, Nokotlek Point, Ongorakvik River; LS78 Kilmantavi, Kuk River, Point Collie, Sigeakruk Point; LS79 Point Belcher, Wainwright, Wainwright Inlet; LS80 Eluksingiak Point, Igklo River, Kugrua Bay; LS81 Peard Bay, Point Franklin, Seahorse Islands, Tachinisok Inlet: LS82 Skull Cliff: LS83 Nulavik, Loran Radio Station: LS84 Walakpa River, Will Rogers and Wiley Post Memorial; LS85 Barrow, Browerville, Elson Lagoon		

Notes: [1] Fraction of a VLOS (expressed as a percent of trajectories) Contacting a Certain LS Within 60 or 360 Days During Summer or Winter From Any LA.

Appendix A, Tables A.2-34, 36, 60, Map A-3b, LA= Launch Area, LS = Land Segment

4.5.15.7. Conclusion

The greatest impacts on archaeological resources from a VLOS 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 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).

4.6. Unavoidable Adverse Effects

Below is a list of resource areas that could experience unavoidable adverse effects under all of the action alternatives. A summary of the types of impacts resulting in unavoidable adverse effects is provided for each resource:

- Water quality: Contamination associated with the discharge of drilling fluids, cuttings, and various types of waste discharges; an increase in suspended sediments due to seafloor disturbance associated with drilling unit anchoring, drilling, platform construction and pipeline installation
- Air quality: Ambient air pollution from pollutant emission from diesel engines associated with vessel traffic, construction activities, and operation equipment in support of oil and gas activities
- Lower trophic level organisms: Impacts to water quality listed above would also adversely affect lower trophic level organisms
- Fish: Similar adverse effects as those to water quality, but with the addition of sound from vessel traffic and oil and gas activity
- Marine and coastal birds (including Threatened and Endangered marine and coastal birds): Contamination of habitat and collisions resulting from the physical presence of vessels, aircraft, and MODUs associated with oil and gas exploration, development, production, and decommissioning
- Marine mammals (including Threatened and Endangered marine mammals): Disturbance resulting from the sound and physical presence of vessels, aircraft, seismic survey equipment, drilling, construction equipment, and infrastructure. Also, impacts to water quality listed above
- Terrestrial mammals: Sound from and presence of aircraft and vehicle traffic, construction activities, and pipeline/facility presence associated with onshore oil and gas activities in support of offshore development
- Vegetation and wetlands: Loss or alternation of vegetation due to onshore construction activities and increased vehicle traffic in support of offshore development

- Economy: Positive impacts could occur
- Subsistence: Adverse effects to marine and coastal birds and marine mammals could also adversely affect subsistence-harvest patterns
- Sociocultural systems: Adverse effects to subsistence-harvest patterns, cultural perceptions of increased oil and gas activity, and increased population, infrastructure, and revenue associated with oil and gas development
- Public health: Population influx influencing communicable disease patterns, increasing social stressors/tensions, and contributing to possible increases in mental health/substance abuse issues
- Environmental justice: Similar impacts as those to public health
- Archaeological resources: Ground and seafloor disturbing activities conducted in areas not previously surveyed have the potential to adversely affect archaeological resources.

A VLOS is not considered in this section because it is extremely unlikely and the adverse effects from one are not considered "unavoidable."

4.7. Relationship between Local Short-Term Uses and Maintenance and Enhancement of Long-Term Productivity

The analysis of the Scenario found that oil exploration, development, production, and decommissioning activities would entail some impacts to nearly all resource areas. 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 is archaeological resources. The destruction of archaeological sites and/or unauthorized removal of artifacts could occur during normal oil and gas exploration, development, production, and decommissioning activities, and would represent an inherently long-term loss. The potential for such impacts exists under each action alternative.

A low probability VLOS event could cause long-term impacts to a variety or 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, public health, Environmental Justice, and archaeological resources. The potential for such impacts exists under each action alternative.

4.8. 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 issuing OCS leases do not constitute an irreversible and irretrievable commitment of resources. The OCSLA prescribes a four-stage process for the OCS program. 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 and environmentally sound manner. In the first stage, BOEM prepares a five-year leasing program to identify the size, timing, and location of proposed lease sales and an EIS under NEPA. In the second stage, BOEM conducts prelease process and sale-specific NEPA review. The third stage involves exploration of the leased tracts. Prior to any exploration drilling, a lessee must submit an exploration plan (EP) to BOEM 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. If exploration drilling is successful, a lessee may then submit a Development and Production Plan (DPP) to BOEM for the fourth stage of review and approval.

Irreversible and irretrievable effects could occur only as a result in exploration, development, production, and decommissioning activities. Each of these activities occur at a future stage of the OCSLA process and would require additional NEPA review that would identify any irreversible and irretrievable commitment of resources associated with the decision at hand.

Chapter 5

Cumulative Effects

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CHAPTER 5. CUMULATIVE EFFECTS

5.1. Introduction

This section analyzes the potential cumulative effects of the Proposed Action and its alternatives. This analysis employs the definition of cumulative impacts found in the CEQ regulations (40 CFR 1508.7):

> Cumulative impact is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or Non-federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

Cumulative effects are assessed by determining the incremental impact of the action when added to the impacts of past, present, and reasonably foreseeable future actions in the vicinity of the project. The ultimate goal of identifying potential cumulative effects is to provide for informed decisions that consider the total effects (direct, indirect, and cumulative) of the project alternatives. As suggested by the CEQ handbook, "Considering Cumulative Effects Under the National Environmental Policy Act (CEQ, 1997b)," the following basic types of effects are also considered:

- Additive – the sum total impact resulting from more than one action
- Countervailing – adverse impacts that are offset by beneficial impacts
- Synergistic – when the total impact is greater than the sum of the effects taken independently

Cumulative effects may result from the incremental accumulation of similar effects or the synergistic interaction of different effects. Repeated actions may cause effects to build up over time, or different actions may produce effects that interact to produce cumulative impacts greater than (or less than) the sum of the effects of the individual actions.

5.1.1. Framing the Analysis

This cumulative effects analysis is structured as follows:

- BOEM identified the potential effects resulting from the Proposed Action and other alternatives, on the marine, coastal, and human environments, which are interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment.
- BOEM identified other past, present, and reasonably foreseeable future actions and their effects on the marine, coastal, and human environments. The past, present and reasonably foreseeable future actions considered for the cumulative effects analysis in this Second SEIS are identified in Tables 5-2 to 5-12, and are described in the subsequent sections of this chapter. In identifying past, present, and reasonably foreseeable future actions germane to this analysis, BOEM considered:
    - Past oil and gas activities - activities that resulted in existing infrastructure
    - Present oil and gas activities - activities for which new facilities are under construction
    - Reasonably foreseeable future oil and gas activities - activities that are reasonably foreseeable during the life of the Proposed Action. These include potential projects in the U.S. and Russian waters of the Chukchi Sea, and projects in the U.S. and Canadian waters of the Beaufort Sea

  - o BOEM also considered past, present and reasonably foreseeable future actions other than oil and gas activities
- BOEM determined the incremental contribution of the Proposed Action, and other alternatives, to the cumulative case using the Scenario (Section 2.3.5). Regardless of the Action Alternative selected, the Scenario analysis projects activities that produce 4.3 Bbbl of oil.

BOEM's analyses reflect the greater clarity and certainty with which future actions occurring closer to the present can be evaluated. Effects determinations for future actions occurring closer in time are inherently more reliable. Also, analyses were considered in the context of a warming climate. A warming climate could contribute to cumulative effects through:

- 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
- Increased ocean acidity
- Range extension of species into the Arctic
- Changes in timing and magnitude of plankton blooms
- Changes in subsistence-hunting practices
- Changes in potential for community economic development and regional tourism activities

Reasonably foreseeable production estimates from oil and gas from Lease Sale 193 leases and other reasonably foreseeable future activities also informed the analysis (Table 5-1).

Table 5-1. Reasonably Foreseeable Future Production: Lease Sale 193/Other Activities.

Activity	Oil (BBbl)	Gas (TCF)
Chukchi Sea Lease Sale 193 Leased Area	4.3	2.2
Chukchi Sea Outer Continental Shelf Future Lease Sales	2.0[3]	1.9[3]
National Petroleum Reserve in Alaska	0.76[1]	17.39[1]
Colville-Canning (includes State Beaufort Sea)	3.15[2]	33.3[2]
Beaufort Sea Outer Continental Shelf	1.1[4]	5.75[4]
Total	11.21	60.54

Notes: Potential Production from Lease Sale 193 Leases and from Other Reasonably Foreseeable Future Activities; . This table only includes the highest estimated recovery from the Outer Continental Shelf.
Sources: [1] USDOI, BLM (2012) Sec. 4.2.1.2, NPR-A
[2] Thomas et al. (2009) for Colville-Canning.
[3] USDOI, BOEM (2014b).
[4] USDOI, BOEM (2012) Table 4.6.1-3 Beaufort Sea.

5.1.2. Past, Present, and Reasonably Foreseeable Future Actions

A summary of past, present and reasonably foreseeable future actions that could potentially impact the marine, coastal, and human environments are analyzed in this section. General categories of these actions are introduced and discussed in Table 5-2. These include oil and gas activities, community development, recreation and tourism, marine vessel traffic, aircraft traffic, subsistence activities, research and survey activities, mining projects, military activities, and climate change (including ocean acidification).

Table 5-2. Relevant Past, Present and Reasonably Foreseeable Future Action Categories.

Table	Category	Area	Type of Action
5-3 and 5-4	Oil and Gas Activities (non-Lease Sale 193)	State and Federal Waters (Beaufort and Chukchi Seas); Onshore Alaska North Slope; MacKenzie Delta (CAN) and Beaufort Sea; Russian Chukchi Sea	Geological and Geophysical Surveys; Infrastructure Development; Construction and Maintenance; Exploration; Energy Development and Production

Table	Category	Area	Type of Action
5-5	Community Development	North Slope Borough; Northwest Arctic Borough; Nome Census Area; Yukon and NW Territories (CAN); Russia community expansion	Demographic/Population Change, Migration; Commercial Fishing; Infrastructure Development Projects; Energy Development
5-6	Recreation and Tourism	Bering, Beaufort, and Chukchi Sea and Adjacent Near Shore Area	Wildlife viewing; Sport/commercial guiding and fishing; Recreation activities; Cruise ships and commercial vessels
5-7	Marine Vessel Traffic	US and Canada Beaufort Seas; U.S. and Russia Chukchi seas; Nearshore Beaufort and Chukchi Seas	Industry vessels, oil field support and transports; Community barge and supply vessels; Global Shipping through the Arctic; Research Vessels; Commercial Fishing Vessels
5-8	Aircraft Traffic	Beaufort and Chukchi Seas; Overland	Industry Crew Transfers; Commercial and private flights, National and International Cargo Flights; Expansion of airfields; Research flights
5-9	Subsistence Activities	Atqasuk, Barrow, Kaktovik, Kivalina, Kotzebue, Nuiqsut, Point Hope, Point Lay, Shishmaref, Wales, Wainwright, and Russian Northern Chukchi Sea Coastal Communities	Subsistence hunting, fishing, and gathering; Whaling; Traveling (small marine vessels, all land vehicles)
5-10	Research and Survey Activities	Nearshore and offshore waters (Beaufort and Chukchi seas); Onshore	Studies and Surveys: Oceanographical; Biological; Geophysical Archaeological; Socioeconomic
5-11	Mining Projects	North Slope Borough; Northwest Arctic Borough; Nome Census Area	Resource extraction
5-12	Military/Homeland Security Activities	Coastal sites (Northwest Alaska, North Slope); Federal waters (Beaufort and Chukchi seas)	Distant Early Warning Line Sites maintenance and demolition; Marine and air vessel presence; Onshore base/infrastructure/personnel

5.1.2.1. Oil and Gas Activities

Past and Present Oil and Gas Activities

As explained by BLM (USDOI, BLM, 2012, Section 4.8.3.1), onshore oil development has been the main agent of industrial change on the North Slope, and throughout the Arctic OCS in the twentieth and twenty-first centuries. Oil and gas exploration activities have occurred on the North Slope since the early 1900s, and oil production has occurred for over 35 years from Alpine in the west to Badami in the east. Onshore gas production from the Barrow gas field, subsidized by the Federal government, began over 60 years ago. Associated industrial development has included the creation of industry-supported community airfields at Deadhorse and Kuparuk, and an interconnected industrial infrastructure that includes roadways, pipelines, production and processing facilities, gravel mines, and docks.

In 1977, the Trans-Alaska Pipeline System began to transport North Slope crude oil to a year-round marine terminal in Valdez, Alaska. Today, it continues to transport the North Slope’s entire onshore and offshore oil production, and it is projected to do so for many years into the future. Past and present on- and offshore oil and gas facilities in the U.S. Arctic are summarized in Table 5-3.

Definitions:

- Field—an area consisting of a single reservoir or multiple reservoirs all grouped on, or related to, the same general geologic structural feature and/or stratigraphic trapping condition. Fields are currently or will soon be producing hydrocarbons.
- Satellite—a small prospect or field which must use infrastructure from another field in order to be economic
- Pool—a discovered or undiscovered accumulation of hydrocarbons, typically within a single stratigraphic setting
- Prospect—a geologic feature having the potential for trapping and accumulating hydrocarbons
- Show—a one-well discovery with poorly defined limits and production capacity

Endicott Island, built in 1987, was the first continuously producing offshore oil field in the Arctic. In 1999, construction began on another offshore island for oil production, known as Northstar. Northstar, as well as the Nikaitchuq and Oooguruk developments, currently operates in nearshore areas of the Beaufort Sea, and is expected to continue operating in the future. Additional oil and gas activities that have occurred in the Beaufort Sea and Chukchi Sea OCS to date include exploration wells, exploration seismic surveys, geohazard surveys, geotechnical sampling programs, and baseline biological studies and surveys.

Table 5-3. Past and Present U.S. Arctic Oil and Gas Discoveries as of May 2014.

Sort	Production Facility Name	Production	Location	Discovery	Production Date**	Category	Ranking Criteria
Past Development (Production in Past, Present, and Future)							
1	South Barrow	Gas	Onshore	1949	1950	Field	Production Began
2	Prudhoe Bay	Oil	Onshore	1977	1969	Field	
3	Kuparuk River	Oil	Onshore	1969	1981	Field	
4	East Barrow	Gas	Onshore	1974	1981	Field	
5	Lisburne	Oil	Onshore	1969	1982	Field	
6	Milne Point/ Kuparuk River	Oil	Onshore	1969	1985	Field	
7	Endicott	Oil	Offshore	1978	1986	Field	
8	Sag Delta North/Ivishak	Oil	Offshore	1982	1989	Satellite1	
9	Schrader Bluff	Oil	Onshore	1969	1991	Satellite3	
10	Walakpa	Gas	Onshore	1980	1992	Field	
11	Point McIntyre	Oil	Onshore	1988	1993	Field	
12	Niakuk	Oil	Onshore	1985	1994	Field	
13	Sag River	Oil	Onshore	1965	1995	Satellite3	
14	Cascade	Oil	Onshore	1993	1996	Field	
15	West Sak	Oil	Onshore	1971	1997	Satellite2	
16	Badami	Oil	Onshore	1990	1998	Field	
17	Tarn	Oil	Onshore	1991	1998	Field	
18	Tabasco	Oil	Onshore	1986	1998	Satellite2	
19	Midnight Sun	Oil	Onshore	1997	1998	Satellite4	
20	Aurora	Oil	Onshore	1969	2000	Satellite4	
21	Alpine	Oil	Onshore	1994	2000	Field	
22	Polaris	Oil	Onshore	1969	1999	Satellite4	
23	Northstar	Oil	Offshore	1984	2001	Field	
24	NW Eileen/Borealis	Oil	Onshore	1969	2001	Field	
25	Meltwater	Oil	Onshore	2000	2001	Field	
26	Orion	Oil	Onshore	1968	2002	Satellite	
27	Palm	Oil	Onshore	2001	2002	Field	
28	Fiord (CD 3)	Oil	Onshore	1992	2006	Field	
29	Nanuq (CD 4)	Oil	Onshore	2000	2006	Field	
30	Qannik	Oil	Onshore	2006	2008	Field	
31	Raven	Oil	Onshore	2001	2006	Field	
32	Nuiqsut	Oil	Offshore	1992	2008	Field	
33	Oooguruk-Kuparuk	Oil	Offshore	1992	2008	Field	
34	Torok	Oil	Offshore	1992	2008	Field	
35	Hooligan	Oil	Offshore	1984	2010	Field	
36	Nikaitchuq-Schrader Bluff	Oil	Both	2004	2011	Field	
Present Development (Production in Present, and Future)							
37	Mustang	Oil	Onshore	2012	(2014)	Field	Production Expected
38	Alpine West (CD 5)	Oil	Onshore	1998	(2015)	Field	
39	Point Thomson	Gas and Oil	Onshore	1977	(2016)	Field	

Notes: **Began or Estimated
All table notes from Table 5-4 apply.

Limited oil and gas activities occurred in the Chukchi Sea after Lease Sale 193 leases were issued. The most significant was the exploration drilling conducted by Shell Gulf of Mexico Inc. during the

2012 drilling season. After commencing drilling on September 9, 2012, an operator drilled a top hole (a very shallow well where the top of the well is established for further drilling at another time, but no liquid hydrocarbon zones are penetrated by the well) before temporarily abandoning the well on October 31, 2012. Ancillary activities have also been conducted pursuant to the issued leases. Statoil conducted a site survey and geotechnical soil investigation during the 2011 open water season and Shell conducted marine surveys in 2013, consisting of on-lease shallow hazard, site clearance and ice gouge surveys. Two 3-D and one 2-D Seismic Geological and Geophysical Exploration surveys were conducted in the Chukchi Sea between June and November of 2006. In 2007, 2008, 2010 and 2013, one Geological and Geophysical survey per year was conducted. Geological and Geophysical activities do not require leases and are individually permitted by BOEM after project-specific NEPA review.

Reasonably Foreseeable Future Oil and Gas Activities

In its cumulative effects analysis, BOEM considered reasonably foreseeable future oil and gas activities both offshore and onshore. These activities are identified in Table 5-4.

Table 5-4. Future U.S. Arctic Oil and Gas Discoveries as of May 2014

Sort	Production Facility Name	Production	Location	Discovery	Production Date**	Category	Ranking Criteria
Reasonably Foreseeable Development (Production in Future)							
40	Spark (CD 7/GMT-2)	Gas and Oil	Onshore	2000	(2017)	Field	Production Expected
41	Lookout (CD 6/GMT-1)	Oil	Onshore	2001	(2017)	Field	
42	Tofkat	Oil	Onshore	2012	(2015)	Field	
43	Beechy Point	Oil	Onshore	2012	(2016)	Field	
44	Liberty	Oil	Offshore	1997	(2020)	Field	
45	Stinson	Oil	Offshore	1990	—	Pool	
46	Umiat	Oil	Onshore	1946	—	Pool	
47	North Shore	Oil	Onshore	1969	—	Pool	
48	Mikkelsen	Oil	Onshore	1971	—	Pool	
49	Hammerhead	Oil	Offshore	1985	—	Pool	
50	Sandpiper	Gas and Oil	Offshore	1986	—	Pool	
51	Chukchi Sea OCS	Oil and Gas	Offshore	1990	—	Pools	
52	Sourdough	Oil	Onshore	1994	—	Pool	
53	Yukon Gold	Oil	Onshore	1993	—	Pool	
54	Pete's Wicked	Oil	Onshore	1997	—	Prospect	
55	Rendezvous	Gas and Oil	Onshore	2000	—	Pool	
56	Mooses Tooth	Gas and Oil	Onshore	2001	—	Pool	
58	Tuvaaq	Oil	Offshore	2005	—	Pool	
59	Qugruk	Oil	Onshore	2012	—	Pool	
60	North Prudhoe Bay*	Oil	Onshore	1970	1993-2000	Field	

Note: Footnotes for Satellites identify the associated production unit:
Sources: Field information from State of Alaska, Dept. of Natural Resources Division of Oil and Gas Website and Petroleum News

[1]Duck Island Unit
[2]Kuparuk River Unit
[3]Milne Point Unit
[4]Prudhoe Bay Unit

Parentheses indicate when production startup is expected.

*North Prudhoe Bay was shut-in in 2000 due to safety concerns and may produce again once the concerns are alleviated (Petroleum News)

**West Beach and Eider fields have been shut in and are unlikely to produce again in the near future. New development of the fields may take place if field economics change (E. Lidje for Petroleum News (Lidje, 2013).

Offshore Oil and Gas Activities

Production from Future Chukchi Sea OCS Oil and Gas Lease Sales

To inform the cumulative effects analysis, BOEM estimated how much exploration, development, production, and decommissioning could occur from reasonably foreseeable future lease sales in the Chukchi Sea. During this exercise, BOEM focused on the areas leased in Lease Sale 193 as well as nearby tracts within the "core" leasing area of the Chukchi Sea. This core area contains the most promising prospects, and was the focus of leasing in Lease Sale 109 as well as Lease Sale 193; it is expected to be an area of industry focus in potential future lease sales. Therefore, this is the area where BOEM expects industry interest to remain focused for the foreseeable future. Industry is not expected to pursue prospects outside this core area for the foreseeable future given the less promising geology and economics.

BOEM used economic simulation models to help estimate how much production could occur from prospects in the core area of the Chukchi Sea via future lease sales. Of 1,000,000 simulations, all of which assumed exploration drilling of all economic prospects, 850,000 (or 85%) lacked drilling success and resulted in zero production. To ensure that BOEM's environmental analysts were provided a development scenario to analyze, these unsuccessful results were discarded, and focus shifted to the 15% of results that forecast the discovery of at least one anchor field. For the cumulative case, BOEM then selected a "high case" estimate – equivalent to an extra 1.9 Bbbl of production over and above the 4.3 Bbbl base-case Scenario for Lease Sale 193 – from the remaining subset of successful results[1]. Using data from actual prospects to more accurately develop the proxy fields analyzed here, BOEM estimated the additional 1.9 Bbbl of production attributed to future lease sales could occur from two additional satellite fields. These two satellite fields would contribute 1.5 Bbbl and 0.4 Bbbl of recoverable oil, respectively. Production would also include 1.9 TCF and 0.2 TCF of recoverable gas from these two satellite fields, respectively. Developing these fields would require 6 additional platforms and 360 additional production and service wells.

In order to produce and transport the additional 1.9 Bbbl that could occur from the two additional satellite fields, a portion of the offshore infrastructure developed to produce and transport from Lease Sale 193 leases would need to be retained. Development of recoverable oil from the two additional satellite fields would require exploration and development drilling and construction similar to that projected in the Scenario (Section 2.3.5), including use of the anchor field hub and a portion of the sub-sea pipelines connecting the hub to onshore facilities in order for the additional 1.9 Bbbl to be transported to market.

Deep Penetration Geophysical Surveys Not Associated with Lease Sale 193 Leases

BOEM anticipates that deep penetration geophysical surveys not associated with the leases sold pursuant to Lease Sale 193 will be conducted in both the Chukchi and Beaufort Seas in the foreseeable future. These surveys would consist of seismic surveys, including open-water, towed streamer 2-dimensional (2D) or 3-dimensional (3D) surveys; in-ice towed streamer 2D surveys; on-ice 2D or 3D surveys; ocean-bottom receiver (cable or node) surveys; gravity and gradiometry surveys; and controlled source electromagnetic surveys. These surveys would be conducted to identify prospective blocks for bidding in future lease sales and to optimize drilling sites on leases acquired in lease sales other than Lease Sale 193. BOEM estimates that up to six of these types of surveys could be conducted in each of the Chukchi and Beaufort Seas per year, respectively, which

[1] This 6.4 Bbbl of cumulative production represents the 64th percentile of the top 13% of simulation results. These statistics indicate that the 6.4 Bbbl production estimate corresponds to the 95.3 percentile (chance=0.047, calculated as 0.36*0.13) and therefore represents an extreme, high case of forecast activities. It is also noted that the 6.4 Bbbl cumulative Scenario captures more than half of the UERR for the entire Planning Area.

includes one potential survey involving ice breaking in each sea per year, if necessary. Additionally, shallow coring (core depth of less than 500 feet) may be conducted.

Liberty field

The Liberty field in the Beaufort Sea is approximately 6 miles offshore east-southeast of the Endicott development. Hilcorp is the designated operator of the Liberty Development Unit, with first production at least 6 years away. There are an estimated 80-150 million bbl of recoverable oil at this location. BOEM is in receipt of a proposed development plan which is being reviewed for sufficiency. A pipeline from the OCS field would carry oil to Pump Station 1 of TAPS, Endicott or connect with the existing Badami pipeline and flow to Pump Station 1 of TAPS.

Oil and Gas Activities in Canada and Russia

Canadian interests in their western Beaufort Sea are in both liquefied natural gas (LNG) and hydrocarbon resources concentrated in the nearshore and offshore Mackenzie Delta region, with further licenses for exploration or development in the deeper waters of the Amundsen Gulf region. Industry has built and is projecting to build several nearshore island complexes similar to those in the Northstar and Liberty projects. Conical floating drilling platforms are proposed to be used in deeper waters (Callow, 2012). Geological and geophysical seismic surveys are also planned in order to gather necessary data.

The Siberian Sea is the Russian focus for offshore development in their far east. Rosneft and ExxonMobil have agreed to expand their cooperation under their 2011 Strategic Cooperation Agreement to explore four license blocks Severo-Vrangelevsky-1, Severo-Vrangelevsky-2, and Yuzhno-Chukotsky blocks in the offshore region west of Wrangell Island.

Onshore Oil and Gas Activities

The following projects represent a subset of the reasonably foreseeable future onshore oil and gas activities on the North Slope of Alaska.

Point Thomson

ExxonMobil is developing this field on the North Slope. The development is primarily onshore with an offshore reservoir component. The development project is for a gas condensate field that is currently scheduled to produce condensate via pipeline to Pump Station 1 on the TAPS. Current estimated recoverable condensate resources are 200 million bbl. The first oil production is scheduled for 2016. This development is located on state lands just west of ANWR. The project includes production pads, process facilities, an infield road system, a pipeline, infield gathering lines, and an airstrip. The hydrocarbon reservoir lies mainly offshore. To avoid offshore development and potential impacts on the marine environment, onshore drilling pads close to shore have been selected to enable directional drilling to offshore locations.

Greater Prudhoe Bay/Kuparuk/State Offshore Areas

This main producing part of the Alaska North Slope is expected to have numerous small developments as smaller accumulations of oil are discovered and can be produced using existing infrastructure. BOEM estimates that another 200 million bbl of oil will be developed and produced through existing facilities. All will flow from existing facilities into Pump Station 1 of TAPS. The timing of these developments would be scattered evenly over the next 10 years.

Alpine Unit CD-5

ConocoPhillips, Inc. (CPAI) currently operates their Alpine Central Processing Facility near Nuiqsut, Alaska. CPAI was granted a permit by the U.S. Army Corps of Engineers (Corps) to construct a six mi (9.7 km) gravel road bridge and pipeline crossing over the Nigliq Channel of the Colville River for development of CD-5, a satellite field five miles west of Alpine in the National Petroleum Reserve in Alaska (NPR-A). This would be the first bridge over a major channel of the Colville, and CD-5 would be the first permanent oil development site inside the NPR-A. Although the Alaska District Court determined in June 2014 that the permit issued by the Corps had not been adequately justified, construction on the road and pad has begun. If the plan stays on schedule, production on CD-5 will begin in late 2015 and is estimated to produce roughly 16,000 barrels per day at peak.

Greater Mooses Tooth

Conoco-Phillips has proposed to develop the Greater Mooses Tooth project on Federal onshore lands in the NPR-A located a few miles west of Nuiqsut. Estimates vary, but there are believed to be roughly 120 million bbl of recoverable oil and gas condensate at this location. The maximum production is estimated at 30,000 bbl/day and the pipeline would connect to the existing Alpine pipeline which flows to Pump Station 1 of TAPS. First production is scheduled for 2017.

Pipelines

BOEM also considered proposed onshore and offshore construction of pipelines. One major project still in preliminary engineering and design stages and under environmental review is a proposal put forth by a consortium comprised of major North Slope oil and gas producers ExxonMobil, BP and ConocoPhillips, along with partners TransCanada and the state of Alaska. The development, estimated at $45 billion to $65 billion (2012 dollars), would include a gas treatment plant at Prudhoe Bay to remove carbon dioxide and other impurities from the gas stream; a 42-inch-diameter, high-pressure, 800-mi (1,287 km) pipeline and eight compressor stations to move the gas to a proposed liquefaction plant at Nikiski, on the Kenai Peninsula. The Nikiski site would include LNG storage tanks and a marine shipping terminal for gas exports. The pipeline would be designed to accommodate 3 billion to 3.5 billion cubic feet of gas per day, with an initial mix of gas from the Prudhoe Bay and Point Thomson fields, and room to accommodate other gas fields in the decades ahead. A best case scenario foresees that the engineering, design and permit work could run into 2019, followed by final investment decisions, equipment procurement, construction, with first gas in 2023-2024 should the project move forward to completion. Another pipeline project has been proposed as a backup plan to the previously described large-volume, producer-led gas line project. The State of Alaska’s Alaska Gasline Development Corporation is designing and permitting a 32-inch pipeline that would be buried nearly all of its length from Prudhoe Bay to the Big Lake area of Southcentral Alaska. The pipeline would parallel the Dalton Highway to the Livengood area, cut across the Minto Flats, and proceed south, roughly paralleling the Parks Highway. After exiting a gas treatment plant at Prudhoe Bay, up to 500 million cubic feet of gas a day would pass through the pipeline. Including the treatment plant, the project is anticipated to cost between $5.3 and $9.8 billion. The Alaska Gasline Development Corporation anticipates design, engineering, permitting, and negotiating with potential customers to continue into 2015, followed by four or five years of ordering pipe and major equipment, construction, and gas possibly flowing by 2020. The state is considering the smaller-volume line as a backup plan to meet local needs if the larger project does not move ahead.

Community Development

Community development projects in Arctic communities involve both large and small infrastructure projects. Examples of community development activities are provided in Table 5-5. Examples of major community development projects that are reasonably foreseeable include the construction of a new airport at the Village of Kaktovik, and potential development of a deepwater port and an emergency response facility at Wainwright. Smaller projects resulting from and leading to community growth could further increase demand for public services and infrastructure, such as housing, water, waste disposal and storage, electricity, telecommunications, port and dock construction, roads, and similar consequences of growth. These infrastructure projects would likely generate increases in economic activity, and would also result in increased construction noise, additional marine and aircraft traffic from construction activities, and changes in population demographics. Marine and air transportation would contribute to potential cumulative effects through noise and atmospheric pollution resulting in disturbance of marine mammals and impacts to the subsistence harvest.

Table 5-5. Past, Present, and Reasonably Foreseeable Community Development Projects

Region	Area	Action / Project	Past	Present	Future
U.S. Community Development/Capital Projects	Kaktovik	Marine and air, airport construction	X	X	X
	Nuiqsut	Marine and air traffic	X	X	X
	Barrow	Marine and air traffic	X	X	X
	Wainwright	Marine and air traffic, port construction	X	X	X
	Point Lay	Marine and air traffic	X	X	X
	Point Hope	Marine and air traffic	X	X	X
	Kivalina	Marine and air traffic	X	X	X
	Kotzebue	Marine and air traffic, small boat harbor	X	X	X
Canadian Community Development/Capital Projects	Tuktoyaktuk, Northwest Territories; Aklavik, Yukon Territory	Marine and air traffic	X	X	X
	Inuvik, Northwest Territory (NWT)	Marine and air traffic	X	X	X
Russian Community Development/Capital Projects	Chukotka Region	Marine vessel and Air traffic Deep water port construction,	X	X	X

5.1.2.2. Recreation and Tourism

Recreation and tourism activities have historically occurred in northern Alaska. These activities, such as sport hunting and fishing, are expected to continue in the future at potentially higher levels. Marine and coastal vessel and air traffic associated with recreation and tourism could contribute to potential cumulative effects through the disturbance of marine mammals or impacts to the subsistence harvest. Examples of reasonably foreseeable future recreation and tourism activities are provided in Table 5-6.

Table 5-6. Past, Present, and Reasonably Foreseeable Future Recreation and Tourism.

Activity Type	Area	Action / Project	Activities	Time of Year		Occurrence Period		
				Open Water	Winter	Past	Present	Future
Recreation/Tourism (wildlife watching, flightseeing, cruise ships)	Eastern Beaufort Sea Coastal and Inland - Arctic National Wildlife Refuge	River trips, wildlife viewing, hiking, flightseeing	Aircraft traffic, freshwater vessel traffic	X		X	X	X
	Eastern Beaufort Sea Coastal and Inland - North Slope (Kaktovik)	Wildlife viewing	Aircraft traffic, marine and freshwater vessel traffic	X		X	X	X
	Beaufort Sea Offshore and Nearshore	Cruise ships, ecotours	Marine vessel traffic	X			X	X
Recreational/Sport Hunting/Fishing	Chukchi Sea Offshore	Cruise ships, ecotours	Marine vessel traffic	X			X	X
	Eastern Beaufort Sea Coastal and Inland - Arctic National Wildlife Refuge	Hunting, Fishing, flightseeing	Marine and freshwater vessel traffic, aircraft traffic	X	X	X	X	X

5.1.2.3. Marine Vessel Traffic

Past marine vessel traffic has been associated with subsistence hunting, oil exploration, research, and military activities in the Chukchi and Beaufort Seas. Weather and ice have typically limited marine vessel traffic in these areas to July through September. Future marine traffic patterns may change due to the influence of a longer ice-free period and overall decreased ice cover, potentially increasing the number of vessels associated with industrial transportation, tourism, and non-subsistence fishing. The USCG is conducting a Port Access Route Study to examine establishing ship routing measures in the Bering Sea and Bering Strait. It is expected that most vessels engaged in OCS activity in this lease sale area will follow these shipping lanes as they transit through the Bering Strait unless environmental conditions such as heavy ice cover make following those routes impracticable. The potential expansion and development of deepwater ports such as Murmansk on the northern Russian coast, and Unalaska or Nome along the Alaska coast south of the Chukchi Sea, would likely increase some classes of shipping traffic (Table 5-7). Transits of the Northern Sea Route, which is used by vessels carrying oil and gas products from Russian oilfields to the far east, are usually draft limited to 12 or 13 meters so the maximum size of these vessels is also limited.

Table 5-7. Past, Present and Reasonably Foreseeable Future Marine Vessel Traffic.

Area	Project	Activities	Time of Year		Occurs During		
			Open Water	Winter	Past	Present	Future
Coastal Beaufort and Chukchi Seas	Supply Barges	Marine and freshwater vessels	X		X	X	X
	Native boat traffic	Subsistence, travel, small boats	X		X	X	X
	Industry crew change, supply and materials transfer	Petroleum product offloading, transport, storage, Marine vessel traffic	X		X	X	X
	Arctic deep draft port	Marine vessel traffic	X				X
Offshore Beaufort and Chukchi Seas	Icebreaker and ice management, Northern Sea Route tanker transport of crude oil Marine Vessel Traffic	Marine vessel traffic	X	X	X	X	X
	Crew transfer, transport of supplies and equipment, aircraft traffic	Marine vessel and aircraft Traffic	X	X	X	X	X

Marine vessels are the greatest contributors of anthropogenic sound introduced to the Chukchi Sea. Sound levels, and frequency characteristics of vessel sound generally, are related to vessel size and speed. Larger vessels generally emit more sound than do smaller vessels. Same size class vessels travelling at higher rates of speed generally emit more sound than the same vessels travelling at lesser speeds. Vessels underway with a full load, or vessels pushing or towing loaded non-powered vessels, generate more sound than unladen vessels in a similar size class. The most common sources of marine vessel noise are propulsion engines, generators, bearings, pumps, and other similar components. Operations and navigation equipment, including fathometers and sonar equipment, also contain mechanical components that create and propagate sound into the marine environment. The most intense level of sound pressure introduced into the water from an underway marine vessel originates from cavitation associated with the energy of spinning propellers. Moored vessels can generate sound from the operation of engines and pumps. Cranes or other equipment performing construction activities or other work functions may transmit sound directly to the marine environment through the air-water interface or through propagation of sound waves through hulls or other support structures.

The number of marine vessels in both the Beaufort and Chukchi Seas has increased in recent years due to advances in the technology of ice strengthening and ice breaking capacities, changes in ice cover and classifications of ice, increases in use of both the Northern Sea Route over Russia and the Northwest Passage through Canada for commercial and tourist voyages, and increased interest in scientific and economic pursuits in the area. Reasonably foreseeable future traffic in the region includes small craft involved in the fall whaling hunt at Barrow and Wainwright; USCG vessels; cargo vessels; other supply ships, tugs, and barges; cruise ships; and vessels associated with scientific endeavors. There are also several newly built ice strengthened LNG carriers and more on order that are expected to carry an increasing volume of Russian LNG Cargoes across the Northern Sea Route and through the Bering Strait to markets in the far east.

USCG District 17 (USCG, 2013) has reported that during the period from 2008 to 2012, annual vessel traffic transiting the Bering Strait, which is the entry and exit point to the Western Arctic, increased from 220 to 480 vessels a year (a more than 100% increase). In the last two years, there has been a drop in Bering Strait transits. There were 440 in 2013 and 340 in 2014. The Office of Naval Intelligence (2014) reports Bering Strait transits may increase to more than 1,000 vessels per year by 2025 due to changes in ice patterns across the northern sea routes (a more than 400% increase from 2012). The same publication reports that in 2012, 96 vessel passages occurred in the Northern Sea Route over Russia and the Northwest Passage through Canada combined. That level of activity may increase to 1,000 passages by 2025, due to an increase in open water periods from approximately two to more than five weeks, resulting in cost savings because of shorter routes and transit times. The estimated number of miles of non-seismic vessel traffic in the Chukchi Sea for July through October increased from approximately 2,000 miles in 2006 to more than 11,500 miles in 2010 (Marine Exchange of Alaska, 2011). Vessel tracks from 2009 indicate vessel transits in the vicinity of Barrow and Wainwright are traditionally concentrated along the coast (Marine Exchange of Alaska, 2011).

5.1.2.4. Aircraft Traffic

Air traffic has increased in recent years, mostly from increases in research, survey, commercial, military, and recreational operations. Table 5-8 summarizes past, present, and reasonably foreseeable air traffic in the Beaufort and Chukchi Seas. Aircraft traffic in the Arctic includes fixed wing and helicopter flights for research programs and marine mammal monitoring operations; cargo flights for supplies to villages and for commercial ventures including oil and gas related activities (such as crew changes and supply flights); flights for regional and inter-village transport of passengers; air-ambulance and search and rescue emergency flights; general aviation for the purpose of sport hunting and fishing or flightseeing activities; and multi-governmental military flights. An average of 141 total U.S. carrier flights per month occurred from Wainwright airport and 326 total U.S. carrier flights per month occurred from Barrow's Wiley Post–Will Rogers Memorial Airport between July and October, 2003 to 2013 (http://www.transtats.bts.gov/Data_Elements.aspx?Data=2). Nationally, the Federal Aviation Administration forecasts an average annual increase in aircraft operations of 2.0% for air carriers, 1.5% for air taxis with commuters, and 0.3% for total general aviation through 2032 (FAA, 2012, Table 32).

Table 5-8. Past, Present and Reasonably Foreseeable Future Air Traffic.

Area	Project	Activities	Time of Year		Occurrence Period		
			Open Water	Winter	Past	Present	Future
Beaufort and Chukchi Seas - Coastal	Aerial surveys of marine mammals	Air traffic	X	X	X	X	X
	Scheduled Air Transportation	Aircraft traffic	X	X	X	X	X
	Coastline surveys	Aerial flights for understanding coastal erosion change	X		X	X	X
	Tourism	Flightseeing	X	X	X	X	X
Beaufort and Chukchi Seas - Offshore	Industry crew changes and supply flights	Helicopter air traffic	X	X	X	X	X
	Marine mammal surveys	Aircraft Traffic	X	X	X	X	X

5.1.2.5. Subsistence Activities

Two major subsistence resource categories occur on the North Slope: the coastal/marine and the terrestrial/aquatic (Table 5-9). Coastal/marine food resources include whales, seals, walruses, waterfowl, and fish. Terrestrial/aquatic resources include caribou, freshwater fish, moose, Dall sheep, edible roots and berries, and furbearing animals. Generally, communities harvest resources most available to them. The distribution, migration, seasonal, and more extended cyclical variation of animal populations drive decisions on what, where, and when to harvest a subsistence resource. Many areas might be used infrequently, but they can be quite important harvest areas when they are used. Subsistence activities tend to be concentrated along rivers, lakes, and coastlines, near communities, and where resources are at high abundance levels. Russian Chukotkan communities harvest similar species in similar environments, although Dall sheep are not available, and reindeer herding has supplanted wild caribou hunting.

Table 5-9. Past, Present, and Reasonably Foreseeable Future Subsistence Activities.

Action / Project	Area	Activities	Timing		Occurrence Period		
			Open Water	Winter	Past	Present	Future
Bowhead whale harvest	Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, Kotzebue and adjacent areas	Small boat traffic in fall hunt, snowmachine traffic in spring hunt	X		X	X	X
Harvest of Beluga, walrus, seals		Small boat traffic for open water beluga, walrus, seal hunt; snowmachine traffic in winter seal hunt	X	X	X	X	X
Hunting, gathering, fishing, trapping, and associated activities.	Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, Kotzebue and adjacent areas	Small boat, vehicular, and snowmachine traffic	X	X	X	X	X

The subsistence pursuit of bowhead whales has major importance to the Chukchi Sea communities of Barrow, Wainwright, Point Hope, and Kivalina. Residents of Point Lay hunt whales with crews from Wainwright and some residents of Atqasuk whale with Barrow crews. The sharing of whale muktuk, or fat, and whale meat is important and continues to be the most valued activity in the subsistence economy of these communities. There are regional exceptions to the bowhead whale harvest tradition. In Point Lay, the beluga whale harvest is the mainstay of the community, and most Chukchi Sea communities rely more heavily on the harvest of walrus and seals than do Beaufort subsistence communities. It is anticipated that subsistence activities will continue in the foreseeable future.

5.1.2.6. Scientific Research Activities

Numerous offshore scientific research programs in the Beaufort and Chukchi Seas are conducted annually (Table 5-10). These activities involve vessel, air, and over-ice support which may contribute to cumulative effects through disturbance of marine animals and impacts to subsistence harvest through marine vessel and aircraft traffic, and disturbance of bottom sediments through sampling for biological and chemical studies. For example, BOEM oceanographic research in 2014 included physical oceanography studies, habitat and ecology studies (including distribution of invertebrates), fish, birds, and marine mammal communities in the Chukchi and Beaufort Seas. These included complementary and cooperative studies such as the Hanna Shoal Ecosystem Study, the Chukchi Acoustic Oceanography and Zooplankton program (CHAOZ), and the Chukchi Offshore Monitoring in Drilling Area (COMIDA) program. Collectively, they comprise a comprehensive program funded by BOEM to establish an integrated knowledge of the Chukchi Sea ecosystem. The programs conduct studies to understand a wide variety of biological, chemical, and physical processes, and to establish baseline data sets for benthic infauna and epifauna, organic carbon and sediment grain size, radioisotopes for down core dating, trace metals in sediments, biota and suspended particles, as well as a wide variety of associated parameters. Shell, Conoco Philips, and Statoil have conducted a comprehensive research program over the Chukchi Sea Leased Area since 2008. This research, known as the Chukchi Sea Environmental Science Program, includes multiple marine ecosystem disciplines such as physical, chemical and biological oceanography, plankton ecology, benthic ecology (infaunal and epibenthic communities), seabird ecology, marine mammal ecology, pelagic and demersal fishes, and the hydroacoustic environment. This program will continue through at least 2015.

Table 5-10. Past, Present, and Reasonably Foreseeable Future Scientific Research.

Area	Project	Activities	Timing		Occurrence Period		
			Open Water	Winter	Past	Present	Future
U.S. Beaufort and Chukchi Seas	Arctic Nearshore Impact Monitoring in Development Area (ANIMIDA III)	Long term environmental monitoring, including Boulder Patch kelp beds, sediment and water column contaminants, bioaccumulation, Marine vessel traffic	X		X	X	X
	Bowhead whale satellite tagging study (ADF&G)	Satellite telemetry of bowhead whales, ecology, diving behavior, feeding behavior, Marine Vessel Traffic	X		X	X	X
	Bowhead Whale Aerial Survey Project (BWASP), COMIDA, and Aerial Surveys of Arctic Marine Mammals (ASAMM)	Aerial surveys of the autumn migration of bowhead whales through the Alaskan Beaufort Sea and transect data on all other marine mammals sighted. Aerial traffic	X		X	X	X
	Distributed Biological Observatory (IARPC)	Long term monitoring of active biological zones in the Chukchi and Beaufort Seas, collections of physical and biological data, Marine vessel traffic	X		X	X	X
	U.S. Canada Transboundary Fish and Lower Trophic Communities	Regional area survey of fish and benthic invertebrates, physical oceanography Marine vessel traffic	X		X	X	X
	ShoreZone: Mapping of the North Slope of Alaska	Helicopter flights of coastline, filming of coastal loss and erosion, collecting and mapping coastal vegetation zones Aerial traffic	X		X	X	
	Shorebirds and Infaunal Abundance and Distribution on Delta Mudflats along the Beaufort Sea	Benthic invertebrate collections, bird observations, sediment collections	X		X	X	X
	Ice seal movements and foraging: Village based satellite tracking of ringed and bearded seals	Satellite telemetry studies of ice seals, traditional knowledge component through interviews of village elders Small boat traffic, local	X		X	X	X
	Chukchi Sea Environmental Sciences Program (CSESP)	Physical and chemical oceanography, acoustic moorings, biological sampling of plankton, invertebrates, and fish. Bird and mammal observational data. Marine vessel traffic	X		X	X	X
	Hanna Shoal Ecosystem Study	Physical and chemical oceanography, acoustic moorings, biological sampling of plankton, invertebrates, and fish. Bird and mammal observational data. Marine vessel traffic	X		X	X	X
	Chukchi Sea Acoustic, Oceanography and Zooplankton Study	Physical and chemical oceanography, acoustic moorings, biological sampling of plankton, invertebrates, and fish. Bird and mammal observational data. Marine vessel traffic	X		X	X	X
	Use of the Chukchi Sea by Endangered Baleen and other Whales (Western Extension of BOWFEST)	Aerial surveys of bowhead whales Aerial traffic	X		X	X	X
	COMIDA: Ecosystem Observations in the Chukchi Sea: Biophysical Mooring and Climate Modeling	Physical oceanography, benthic, zooplankton, fish, acoustic, bird, mammal, and ice studies. Marine vessel traffic	X		X	X	X
	COMIDA-CAB: Chemical and Benthos	Chemical oceanography, collection of benthic sediment and biological sampling, Marine vessel traffic	X		X		
	COMIDA: Factors Affecting the Distribution and Relative Abundance of Endangered Whales: Passive Acoustic Detection and Monitoring of Endangered Whales in the Arctic	Aerial surveys of bowhead whales, physical oceanography, benthic, zooplankton, fish, acoustic, bird, mammal, and ice studies. Marine vessel and Aircraft traffic	X		X		

Area	Project	Activities	Timing		Occurrence Period		
			Open Water	Winter	Past	Present	Future
	Pinniped Movements and Foraging: Walrus Habitat Use in the Potential Drilling Areas	Satellite telemetry and tagging of walrus	X		X		
	NASA, USGS, NOAA	Physical oceanography, ice studies, marine mammals population and ecological studies, seismic and side scan radar studies, sediment coring Marine vessel and air traffic	X	X	X	X	X
	Arctic Ecosystem Integrated Survey	Development of a framework to select Habitat Focus Areas, to improve understanding of ecological and hydrodynamic factors pertaining to impacts of oil spills.	X	X	X	X	X
	Office of Naval Research, and other military research ventures	Various studies involving national security interests, maneuvers, etc. Marine vessel and air traffic	X	X	X	X	X
Canadian Beaufort Sea	U.S. Canada Transboundary Fish and Lower Trophic Communities	Regional area survey of fish and benthic invertebrates, physical oceanography Marine vessel traffic	X		X	X	X
	Oceans and Fisheries Canada (OFC) Arctic Fish Ecology and Assessment Research (AFEAR)	Oceanographic and biological sampling, Marine vessel traffic	X	X	X	X	X
	OFC Arctic Marine Mammal Ecology and Assessment Research (AMMEA)	Bowhead tagging, Marine vessel traffic	X	X	X	X	X
	Ocean Fisheries Canada Arctic Stock Assessment movement of ringed seals, belugas, fish survey	Satellite telemetry studies. Aerial surveys, Small vessel traffic	n/a	n/a		X	X
	Canadian High Artic Research Station (CHARS)	Physical, chemical , and biological research, marine mammal research, vegetation and wetlands studies, indigenous studies. Marine vessel and aircraft traffic	X	X		X	X

BOEM-funded Aerial Survey of Marine Mammals (ASAMM) documents temporal and spatial patterns of habitat use by bowhead whales. Also included in marine mammal studies are ice seal aerial survey projects, walrus satellite tagging and aerial surveys, and acoustic studies utilizing biophysical moorings within and near the Chukchi and Beaufort Sea Leased Areas. Local Iñupiat hunters have conducted boat-based surveys of the study area to gather information on bowhead whale behavior and movement in studies based around Barrow. In addition, the bowhead whale satellite tagging study operates annually in the Beaufort and Chukchi Seas. The purpose of the project is to understand migration routes, migration timing, feeding areas, diving behavior, and time spent in areas within the spring and summer ranges of bowhead whales. The study has been operating since 2006 with between two and fifteen tags deployed on bowhead whales during each of those years. Ongoing studies utilizing tagging of ice seals and satellite telemetry have been conducted by the ADF&G, native boroughs, and NMML since the 1980s. The ADF&G is currently operating the BOEM-funded Ice Seal Movements and Foraging: Village-based Satellite Tracking of Bearded and Spotted Seals project through 2017, a project that includes a traditional ecological knowledge component to document the knowledge of village elders and hunters for better understanding the behavior and ecology of ice seals and their capacity to adapt to changing ice conditions in the Arctic.

The Distributed Biological Observatory (DBO), a long term environmental monitoring network started in 2010, is currently running a pilot study focused on sampling five regions in the Chukchi Sea. The U.S. Interagency Arctic Research Policy Committee (IARPC), comprised of representatives from 13 Federal agencies, developed a five-year plan (2013-2017) focused on seven research themes. The development of the DBO was included under the first theme: Sea ice and Marine Ecosystems. Currently, the DBO Implementation Team (IT) consists of 37 participants, 25 from 7 Federal agencies and 12 non-Federal partners. The work of the DBO IT is framed by 11 milestones, 4 of which have been completed and 7 that are in progress. Activities and products supported via collaborations facilitated by the DBO IT include:

- The conduct of annual DBO sampling from various national and international platforms and the provision of a physical oceanographic data portal (NSF/AON)
- DBO sampling during the ICESCAPES program and the development of satellite visualizations products (NASA)
- Provision of web-based assets mapping and a password-protected DBO Data Workspace (AOOS)
- DBO sampling during the RUSALCA program and coordination of national and international contributions to the DBO, via the Pacific Arctic Group (NOAA)
- ANIMIDA sampling sites that may be added to future DBO sites to provide an extension of DBO monitoring into the eastern Beaufort Sea.

The DBO IT is now focused on bringing together data from 2010-2013 sampling efforts, to demonstrate the value added by this national and international, sampling shared-data approach to the investigation of biological responses to a rapidly changing Arctic marine ecosystem. Expanding from the Pacific Arctic sector, the DBO will also serve as a framework for international research coordination via the Arctic Council Circumpolar Biodiversity Monitoring Program (CBMP), and is recognized as a task of the pan-arctic Sustaining Arctic Observing Network (SAON) program. BOEM is participating in this network through expanding the current potential list of future DBO collection sites into the eastern Beaufort Sea using historical, current, and future collections from the BOEM-funded Arctic Nearshore Impact Monitoring in the Development Area (ANIMIDA) long term monitoring project.

The Alaska Ocean Observing System (AOOS) has various sensors and monitors deployed throughout the Leased Area to measure and record meteorological conditions and other environmental variables. AOOS also coordinates and acts as a data repository for numerous academic, government, and industry funded projects, and produces data products through synthesizing those data.

Onshore research is driven primarily by potential effects of the combination of climate change and resultant changing land use patterns by animal and human populations. Rapidly changing landscapes of shifting waterways, permafrost melt, rapid formation and loss of lakes and streams, and eroding shorelines that are increasingly exposed to weather are occurring due to changes in weather patterns and ice extent. Other ecosystem changes such as large storm events and shifting patterns in wind direction and magnitude are affecting this region due to the change in seasonality and extent of ice cover and the protection it historically provided. These factors are driving research projects due to cryosphere changes in relation to extent and change of thermokarst loss and formation, shoreline change, and rate of coastal erosion. Nearshore lagoons and deltas, such as the areas within Kasegaluk Lagoon, are increasingly important in the consideration of ecological studies. Understanding ecosystem change and ecosystem restoration near these important areas is becoming more critical. Ongoing research is occurring through industry-funded and government-funded borough studies. Government and academic research to investigate Arctic-specific science is being funded by BOEM, NOAA, IARPC, Office of Naval Research, NASA, industry, and research institutions. These region-specific institutions include the Canadian High Altitude Research Station, the Barrow Global Climate Change Research facility, international consortiums such as the International Study of Arctic Change, and the IARPC, funded by NSF and reporting to the President of the United States. Overall ecosystem changes and resultant effects in abundance and diversity of fish, tundra and shoreline nesting birds, air quality and transportation of pollutants, changes in use of shorelines by walrus and seal populations, as well as human use patterns and industry infrastructure development, are driving needs for monitoring and more information on baseline data. It is anticipated that scientific research activities will continue into the foreseeable future at potentially greater levels, due to the increased concerns about climate change and associated effects.

5.1.2.7. Mining Projects

Mining takes place in onshore areas adjacent to the Chukchi Sea. Though the majority of mining activities take place onshore, marine and air transportation could contribute to potential cumulative effects through the disturbance of marine mammals and impacts to subsistence harvest. The world's largest known zinc resources are located in the western Brooks Range. As much as 25 million tons of high-grade zinc is estimated to be present near Red Dog Mine, approximately 40 mi (64 km) from the southwest corner of the NPR-A (Audubon Alaska, 2002). The Red Dog Mine port site may also become the port facility for a very large proposed coal mining operation adjacent to the Chukchi Sea. In addition, coal mining prospecting proposals for the Brooks Range have been submitted to ADNR, Division of Mining, Land and Water (DMLW) for approval. Past, present and reasonably foreseeable future activities related to mining activities are summarized in Table 5-11.

Table 5-11. Past, Present, and Reasonably Foreseeable Future Mining Activities.

Area	Action / Project	Activities	Timing		Occurs During		
			Open Water	Winter	Past	Present	Future
Southwest Chukchi Sea Inland - Red Dog Mine	Red Dog Mine	Large inland zinc mine, ore trucked to port facility, aircraft traffic	X	X	X	X	X
Southwest Chukchi Sea Coastal - Red Dog Port	Minerals Export	vessel traffic bringing in supplies, transshipping processed mineral product	X		X	X	X
Western Chukchi Sea Coastal – Western Arctic Coal Project	Coal exploration and development	Vessel traffic bringing in supplies	X				X

5.1.2.8. Military / Homeland Security Activities

Military activity in the Arctic is thought to have increased in recent years, and it may be reasonable to expect that military activity may continue to increase in the foreseeable future. Military activities in the Leased Area include the transit of military vessels through area waters, as well as submarine activity, aircraft overflights, and related maneuvers. However, very little public information is available about future military activity in the region. Military vessel, submarine, and aircraft traffic could contribute to cumulative effects through the disturbance of marine mammals and effects to the subsistence harvest, and the potential for spills (Table 5-12).

Table 5-12. Past, Present, and Reasonably Foreseeable Future Military Activity.

Area	Action / Project	Activities	Timing		Occurs During		
			Open Water	Winter	Past	Present	Future
Eastern Beaufort Sea Coastal -Barter Island	Distant Early Warning Line Sites	Radar site still active, Aircraft traffic, Barge traffic	X	X	X	X	X
Central Beaufort Sea Coastal - Bullen Point SRRS1		Aircraft traffic, Barge traffic	X	X	X	X	X
Central Beaufort Sea Coastal -Flaxman Island SRRS1		Demolition complete			X		
Western Beaufort Sea Coastal -Point Barrow		Demolition complete but radar site still active, aircraft and barge traffic			X		
Eastern Chukchi Sea Coastal -Wainwright		Potential demolition, aircraft and barge traffic			X	X	
Central Chukchi Sea Coastal -Point Lay		Demolition complete			X		

Area	Action / Project	Activities	Timing		Occurs During		
			Open Water	Winter	Past	Present	Future
Central Chukchi Seas Coastal - Cape Lisburne		Radar site still active, aircraft traffic, Barge traffic			X	X	X
Western Chukchi Sea Coastal -Kotzebue		Potential demolition, aircraft and barge traffic			X		
Submarines, other Naval Vessels	Arctic Submarine Laboratory has conducted various arctic activities since 1940 1.	Vessel traffic, sonar impacts, ship strikes	X	X	X	X	X
US Coast Guard icebreakers	POLAR STAR and HEALY icebreakers	Vessel traffic and icebreaking	X	X	X	X	X
US Coast Guard – Chukchi and Beaufort Seas	Arctic Operations and Training Exercises	Shore-, air-, and sea-based operations; includes increased aircraft and vessel traffic, berthing and facilities for personnel,	X	X	X	X	X
Overflights	North American Aerospace Defense Command (NORAD) Elmendorf AFB	Aircraft traffic	X	X	X	X	X

Note: [1] http://www.csp.navy.mil/asl/Timeline.htm) locations unknown

5.1.3. Climate Change

Although it does not constitute a Federal action, climate change is an ongoing consideration in evaluating cumulative effects on environmental resources of the Arctic region, given its ongoing role in the changing Arctic ecosystem (Section 3.1.9). CEQ has issued guidance directing Federal agencies to include a cumulative impacts discussion of climate change, stating that, “Where an agency concludes that a discussion of cumulative effects of GHG emissions related to a proposed action is warranted to inform decision-making, CEQ recommends that the agency do so in a manner that meaningfully informs decision makers and the public regarding the potentially significant effects in the context of the proposal for agency action. This would most appropriately focus on an assessment of annual and cumulative emissions of the proposed action and the difference in emissions associated with alternative actions” (CEQ, 2010).

Research evaluated by organizations such as the Intergovernmental Panel on Climate Change (IPCC) has established that “rising global emissions of GHG are significantly affecting the earth’s climate” (CEQ, 2010, p. 10). As a result of these GHG emissions and subsequent environmental effects, Alaska has warmed more than twice as rapidly as the rest of the United States, with state-wide average annual air temperature increasing by 3°F (1.7°C) and average winter temperature by 6°F (3.3C) over the past 60 years (Stewart et al., 2014). Average annual temperatures in Alaska are projected to rise by an additional 2°F to 4°F (1.1-2.2°C) by 2050. If global emissions continue to increase during this century, temperatures can be expected to rise 10°F to 12°F (5.6-6.7°C) in the north, 8°F to 10°F (4.4-5.6°C) in the interior, and 6°F to 8°F (3.3-4.4°C) in the rest of the state. Even with substantial emissions reductions, Alaska is projected to warm by 6°F to 8°F (3.3-4.4°C) in the north and 4°F to 6°F (2.2-3.3°C) in the rest of the state by the end of the century (Markon, Trainor, and Chapman, 2012).

Due to these influences, climate change is an ongoing factor in the consideration of cumulative impacts in the Arctic region. Climate change has been implicated in changing weather patterns, changes in the classification and seasonality of ice cover, ocean surface temperature regimes, and the timing and duration of phytoplankton blooms in the Chukchi Sea (NMFS, 2013c). These changes have been attributed to rising CO_2 levels in the atmosphere and corresponding increases in the CO_2 levels of the waters of the world’s oceans which have led to the phenomena of ocean acidification (IPCC, 2007a; Mathis et al., 2014). This phenomena is often called a sister problem to climate change, because they are both attributed to human activities that have resulted in increased CO_2 levels in the atmosphere. Ocean acidification in high latitude seas is happening at a more advanced rate compared to other areas of the ocean. The capacity of the Arctic Ocean to uptake CO_2 is expected to increase in response to predicted increase in atmospheric CO_2 levels (Bates and Mathis, 2009). This is due to the loss of sea ice that increases the open water surface area of the Arctic seas. Exposure of cooler surface water lowers the solubility, or saturation, of calcium carbonate within the water which in turn leads to lower available levels of the minerals needed by shell-producing organisms (Fabry et al., 2009).

Measurable changes in climate are ongoing and have been occurring throughout the past century in Alaska (Smith et al., 2005; Wendler and Shulski, 2009) and these changes are projected to occur into the future (Markon, Trainor, and Chapman, 2012). Further discussion of climate change is found in Chapters 3 and 4.

5.2. Analysis of Cumulative Effects

5.2.1. Water Quality

5.2.1.1. Summary of Direct and Indirect Effects

Direct and indirect effects on water resources from the Proposed Action and alternatives are analyzed in detail in Chapter 4; these direct and indirect effects on water resources are summarized here.

Water resources would be affected by the following factors during exploration, development, production, and decommissioning activities: oil and gas offshore discharges; marine vessel discharges; MODU anchoring; submarine pipeline trenching and installations; water withdrawals; oil and gas facility discharges onshore; installation of onshore pipelines; gravel mining for construction and maintenance of onshore facilities and roads; potential for introduction of aquatic invasive species, including pathogens; accidental small spills; and potential large spills. The effects from these activities on water resources include: introduction of contaminants; increased suspended sediments; increased turbidity; and disruption of flow, decreased water levels, and physical alteration of ponds, lakes, and streams.

Discussion of Other Relevant Actions

The Proposed Action could add incremental impacts to the environment when added to other past, present, and reasonably foreseeable actions affecting water resources. There are several types of actions that have occurred in the past, are currently occurring, or may occur in the foreseeable future that affect or could affect water resources over time in the U.S. Chukchi Sea and freshwater estuarine waters in the surrounding lands (Table 5-13). These actions originate (or could originate) in the U.S. Arctic, Canadian Arctic, or the Russian Arctic.

Table 5-13. Actions that Could Affect Water Resources.

Actions that Could Affect Water Resources	Potential Types of Effects on Water Resources
Offshore oil and gas (other than the Chukchi Sea 193 Leased Areas) Oil and gas exploration wells were drilled, decommissioned in the past; potential new exploration wells, new development and production wells, and new submarine pipelines	Discharges of contaminants (as permitted under NPDES); Increase in suspended sediments and turbidity; Decrease in dissolved oxygen in bottom water Risk of introducing aquatic invasive species; Hydrocarbon introduced from small spills and accidental large spills; Elevated sea surface temperature and salinity
Commercial fishing: Currently commercial fishing is prohibited in the U.S. Arctic; commercial fishing is in U.S. Arctic is possible in the future. Commercial fishing currently occurs in Russian and Canadian Arctic	Discharges from vessels: Risk of introducing aquatic invasive species; Increased suspended sediment and turbidity (trawling): Hydrocarbons introduced from small spills
Marine vessel traffic and anchoring : Global shipping vessels; oil and gas vessels, cargo vessels, military vessels, supply barges, cruise ships, commercial fishing vessels, survey vessels, research vessels	Discharges from vessels: Risk of introducing aquatic invasive species; Increased suspended sediment and turbidity; Hydrocarbons introduced from small spills; Hydrocarbons introduced from ship groundings or spills

Actions that Could Affect Water Resources	Potential Types of Effects on Water Resources
Offshore telecommunications: Arctic submarine cable survey in U.S. Chukchi Sea and U.S. Beaufort Sea in 2014; seafloor trenching and cable laying in 2015, with a landfall in Prudhoe Bay cables	Vessel discharges: Bottom disturbance, increased suspended sediments and turbidity; Risk of introducing aquatic invasive species; Hydrocarbons introduced from small spills
Onshore oil and gas; Exploration, development, production, and decommissioning; Wells drilled at Prudhoe Bay, Kuparuk, Alpine, Greater Mooses Tooth, and other sites on North Slope; onshore pipelines and access roads.	Discharges from operations: Bottom habitat disturbance, increased suspended sediment, increased turbidity (freshwaters); Water withdrawals; Risk of introducing freshwater invasive species; Hydrocarbons introduced from small spills
Onshore construction and maintenance: Projects developed by community, industry (other than oil and gas), Federal and state governments, and military entities. Ports, docks, roads, gravel pads, bridges, runways, ice roads, energy projects, wastewater plants, etc.	Discharges from operations; Bottom habitat disturbance, increased suspended sediment, increased turbidity (freshwaters); Risk of introducing freshwater invasive species; Hydrocarbons introduced from small spills
Onshore mining: Hardrock mining; gravel mining; coal mining; placer mining, and associated road and facility construction and maintenance.; Red Dog hardrock mine, road, and port since 1986; potential Ambler Mining District and Upper Kobuk Mineral Project; potential coal mining projects in Brooks Range; historic placer mining on Seward Peninsula	Marine vessel discharges (at ports); Discharges from mines - increased suspended sediment, turbidity, and metals (freshwaters); Port site discharges and spills; Non-point runoff ; Water withdrawals (freshwater); Risk of introducing freshwater invasive species: Hydrocarbons introduced from small spills
Climate change:	Changes in terrestrial, atmospheric, and aquatic environments. Climate change affects the other actions described in this table through various pathways.

5.2.1.2. Analysis of Cumulative Impacts

Several studies have examined the effects of climate change on water resources. These studies emphasize: warming sea surface temperatures; increasing acidification of the ocean; the implications of decreasing Arctic sea ice, snowpacks and glaciers; changes in river and stream discharges; and changes in lake and pond levels (Mathis et al., 2014; SeaGrant Alaska, 2012).

Climate change effects in the Arctic are causing (and will continue to cause) changes in marine and freshwater environments (Table 5-14).

Table 5-14. Climate Change Effects in the Arctic and Examples of Effects on Water Resources.

Climate Change Effects in the Arctic
Warming sea temperatures
Acidification of seawater (decrease in pH)
Sea ice extent and thickness decreasing: increased sea surface exposed for accelerated warming of water; greater area for air-sea exchange of carbon dioxide; decreases in surface salinity
Coastal erosion increasing
Aquatic invasive species, risk of introduction
Warming pond temperatures – changes in surface area and levels (“drying”)
Melting permafrost – erosion of riverbanks and streambanks; changes in riparian vegetation and channel morphometry
Snowpack melt increasing - river discharge increase, sea surface water salinity decrease

Sources: Guinotte and Fabry, 2008; Mathis et al., 2014

Oil and gas operations associated with the Scenario would cause an incremental effect on water resources if permitted in the future. Oil and gas operations would add marine vessel traffic (potential groundings), increased operational discharges, spills, pipeline leaks, and potential large and very large spills (VLOS) to already existing marine and land-based actions (Table 5-13). Potential leaks from decommissioned wellhead structures and remaining onshore oil and gas pipelines from the Proposed Action could add a future incremental impact on water resources when added to water resource impacts from other marine and shore-based future actions.

Vessel Traffic

The Proposed Action would increase vessel traffic over 77 years, adding to increasing vessel traffic from global shipping vessels, oil and gas vessels, cargo vessels, military vessels, supply barges, cruise ships, commercial fishing vessels, survey vessels, and research vessels. The incremental increase in vessel traffic from the Proposed Action would increase the occurrence of small spills, the risk of introducing aquatic invasive species, and the possibilities of spills or vessel groundings, all of which would affect water quality.

Offshore Oil and Gas

The Proposed Action would increase offshore oil and gas operations over 77 years, adding to past offshore exploration wells (now plugged and decommissioned) and other future offshore oil and gas operations not associated with Lease Sale 193 (Table 5-13). The Proposed Action would add incremental impacts to water resources from: discharges; bottom habitat disturbance and resulting suspended sediments; water withdrawals; risk of introducing aquatic invasive species; small spills; and accidental large spills.

Offshore Telecommunications Submarine Cables

The Proposed Action would disturb the seafloor during some operational phases over 77 years, adding to seafloor disturbance (and effects on water quality) from trenching, and laying fiber optic cable north through the Chukchi Sea to Prudhoe Bay and northeast through the Canadian Arctic.

Onshore Development and Mining

The Proposed Action would increase onshore construction and maintenance projects and facilities over 77 years, adding to the effects from past present and future onshore development and mining (Table 5-13) that affect water resources. The Proposed Action would add incremental impacts on water resources from water withdrawals from streams, ponds, and lakes; permitted discharges into freshwaters; permitted discharges to nearshore waters; non-point runoff from construction of support facilities and roads; and gravel mining for construction of roads, pads, and rights-of-way.

5.2.1.3. Summary/Conclusion

There are a variety of other activities that will result in discharges or otherwise impact water quality. The impacts from past, present and reasonably foreseeable actions on water quality is minor. The Proposed Action would contribute minor to moderate impacts to water resources in addition to the impacts from past, present and reasonably foreseeable actions noted in Table 5-2.

5.2.2. Air Quality

The evaluation of cumulative effects on air quality focuses on the impacts to the onshore areas nearest the Proposed Action and the Alaska communities along the coastline adjacent to the Chukchi Sea OCS Planning Area. The qualitative analysis is based on the behavior of pollutants released during activities associated with the Scenario, and how the pollutants are diluted and diffused by surrounding air and the wind. The duration of the effects, if any, are temporary, as pollutants are assumed to remain within the main exhaust plume only until impact with the ground – they are not additive, meaning the impact is less than the sum of the parts. Afterwards, the pollutants scatter and are further diluted into the surrounding air, causing ever decreasing effects as they are transported farther from the source and around the globe.

5.2.2.1. Summary of Direct and Indirect Effects

Effects of emissions associated with the Scenario are caused by the discharge of diesel-engine exhaust gases resulting from combusting fossil fuels in mobile and stationary engines used to construct, implement, and operate each phase of the Scenario. Additional evaporative emissions of VOCs would occur from small spills. The dominant air pollutant throughout the Scenario is NO_x as analyzed in the air quality analysis in Section 4.3.2. Each phase of the Proposed Action results in a negligible—or in the case of the Exploration, Development, and Production period (years 10-25), minor—air quality impact to the countervailing effects of wind and the dilution and diffusion of the pollutants over space and time, and the extensive distance (>60 statute miles) from shore where the emissions from the Scenario originate.

Mobile sources of emissions from the Scenario would not produce emissions in mass sufficient to overwhelm the effects of their own movements combined with wind and transport (dilution and diffusion) over space and time. As such, accumulation of the pollutants in a single onshore location would not occur, and deterioration of air quality due to the Scenario emissions would not follow.

Projected emissions from stationary sources associated with the Scenario would be regulated under the BOEM AQRP (30 CFR Part 550 Subpart C), which requires compliance before specific proposed plans for operations may begin. Stationary sources whose emissions would cause an exceedance of ambient air quality standards incorporated into the BOEM AQRP would be required to apply Best Available Control Techniques (BACT) to reduce emissions so that the emissions are not deemed to significantly affect the air quality of the onshore area.

5.2.2.2. Discussion of Other Relevant Actions

The past, present, and reasonably foreseeable future actions listed in Table 5-2 each represent potential air emissions either onshore or near-shore. Most of the actions can be characterized as mobile or stationary sources. Several of these actions require aerial surveys using helicopters and small aircraft or transportation by motor vehicles or other over-ice types of vehicles, or use of marine vessels. There are many sources of emissions already existing on the North Slope. However, none produces air emissions that cause an exceedance or violation of the National Ambient Air Quality Standards (NAAQS). If any of the existing sources had any significant air quality effect onshore, the onshore air pollutant monitors would have recorded the exceedances and violations, and this has not occurred. A summary of the background concentrations EPA approved for both the onshore areas adjacent to the Chukchi Sea OCS and Beaufort Sea OCS, is provided in Table 5-15.

Table 5-15. Comparison of North Slope Background Concentrations to the NAAQS

Pollutant	Averaging Period	EPA-Approved Background Concentrations (μg/m^3)	NAAQS (μg/m^3)	Background Percent of the NAAQS
NO_2 Nitrogen dioxide	1-hour	NA	188	NA
	Annual	2	100	2.0%
$PM_{2.5}$ Fine particulate matter	24-hour	11	35	31.4%
	Annual	2	12	16.7%
PM_{10}- Coarse particulate matter	24-hour	79	150	52.7%
SO_2 Sulfur dioxide	1-hour	23	196	11.7%
	3-hour Secondary Standard	14	1,300	1.1%
	24-hour	5	Revoked	NA
	Annual	0.4	Revoked	NA
CO Carbon monoxide	1-hour	959	40,000	2.4%
	8-hour	945	10,000	9.5%

Source: EPA. 2011b,Table 4.

The EPA-approved background concentrations given in Table 5-15 were recorded at the Wainwright Permanent monitoring site since 2009, replacing the Wainwright Near-Term monitoring site. EPA states in their 2011 “Supplemental Statement of Basis for Proposed Outer Continental Shelf Prevention of Significant Deterioration Permits Noble Discoverer Drillship,” that the information in Table 5-15 above summarizes, “the background concentrations that Region 10 is relying upon for the air quality analyses for the 2011 Revised Draft Permits” (EPA, 2011b).

5.2.2.3. Analysis of Cumulative Impacts

Most emissions from the Proposed Action are *de minimis* or are shown to not exceed the Significance Levels (40 CFR 51.165(b)(2). According to the EPA, the purpose of the Significance Levels is to provide a screening tool to identify a level of ambient impact that is "sufficiently low relative to the NAAQS or PSD increments, such that the impact can be considered trivial *de minimis*" (EPA, 2010a, p. 11). Further, "EPA has long maintained that any further effort on the part of the applicant to complete a cumulative source impact analysis involving other source impacts would only yield information of trivial or no value with respect to the required evaluation of the proposed source [Proposed Action] or modification" (EPA, 2010a, p.11). Therefore, a qualitative evaluation of cumulative air quality effects is provided.

Past Actions

Past actions described in Table 5-2 did not occur simultaneously with activities associated with the Proposed Action, and emissions from those past actions would already be dispersed throughout the atmosphere. As such, the EPA has determined the North Slope, in its entirety, is an area of clean air resources where there are no exceedances or violations of the NAAQS, as shown in Table 5-15. In fact, the whole North Slope is designated as a Class II area of clean air that warrants special protection to avoid air quality impacts, as discussed in Section 3.1.7.1. Air quality impacts from activities associated with the Proposed Action, when combined with past actions and emissions from those actions, would not have the potential to cause a significant level of effect, and would have a negligible level of cumulative effects to onshore air quality.

Present and Future Oil and Gas Activities

Present and potential future actions of oil and gas operations on the Chukchi Sea OCS, which are not associated with the Scenario, include seismic surveys, infrastructure development, and production, and would likely have the same overall negligible onshore air quality effect as analyzed for the Scenario in air quality Section 4.3.2. This is because air quality effects are not additive, meaning the impact is less than the sum of the individual effects, as discussed in the Impacts of the Scenario through Time Section 4.3.2. Thus, air quality impacts from activities associated with the Proposed Action, together with present and potential future oil and gas actions and emissions from those actions, would not have the potential to cause major effects, and would have a negligible to minor level of cumulative effects to onshore air quality.

Other Present and Future Actions

Present and reasonably foreseeable future actions not associated with gas and oil activities involve mainly mobile sources of emissions, such as commercial travel (aircraft and vessels) related to fishing, wildlife viewing, sporting, and other recreation and tourism; temporary demolition and building of infrastructure; mining projects; and subsistence activities. Emissions from these sources described in air quality Section 4.3.2 and would all likely have the same overall effect as mobile sources in general. Briefly, mobile sources cause emissions to be discharged over time and space, spreading out the plume of pollutants. At the same time, the elongated plume is being diluted (mixing with surrounding air) and diffused (plume continually expanding throughout both the vertical and horizontal planes). Also, the present and potential future mobile emissions would occur onshore or near-shore. The projected emissions from the Proposed Action would occur at least 60 statute miles offshore. This means the projected emissions from the Proposed Action would not be likely to mix with pollutants from the present or reasonably foreseeable future actions. The overall effect of emissions from mobile sources, onshore or offshore, would be mitigated at the source of the manufacturer, who is responsible for following Federal guidelines for emission standards for engines. Thus, air quality impacts from activities associated with the Proposed Action, together with other present and reasonably foreseeable future actions and mobile emissions from those actions, would not have the potential to cause major effects, and would have a negligible to minor level of cumulative effects to onshore air quality.

Present and reasonably foreseeable future actions that involve mainly stationary sources of emissions, such as operation of new infrastructure, and operating military bases, would all likely have negligible impacts even when considered together with projected emissions from the Proposed Action. Similar types of activities already occur on the North Slope, particularly near Prudhoe Bay, Alaska, where the population can swell to several thousand people as transient oil and gas worker support the Prudhoe Bay oil field, the largest oil field in the United States. The EPA has determined that operations of all the oil and gas activities, together with stationary facilities that are sufficient to support several thousand people at Prudhoe Bay, do not cause emissions sufficient to exceed or cause a violation of the NAAQS. Further, the Proposed Action would occur at least 60 statute miles offshore, which means the projected emissions from the Proposed Action would disperse almost completely before reaching the shore, allowing no mixing. Thus, air quality impacts from activities associated with the Proposed Action, together with other present and reasonably foreseeable future actions and stationary emissions from those actions, would not have the potential to cause major effects, and would have a negligible to minor level of cumulative effects to onshore air quality.

5.2.2.4. Summary/Conclusion

Possible cumulative air quality effects onshore would be mitigated due to the consistent wind velocity over the Chukchi Sea OCS (dilution and diffusion), the distance from shore of the Proposed Action, the lack of profuse emissions from present and reasonably foreseeable future onshore and near-shore sources, and the negligible effect to onshore air quality of the Proposed Action's. The overall contribution to onshore air quality impacts from activities associated with the Proposed Action, when combined with impacts from the other past, present, and reasonably future actions and emissions described in table 5-2, is negligible to minor.

5.2.3. Lower Trophic Organisms

5.2.3.1. Summary of Direct and Indirect Effects

Effects on lower trophic organisms during exploration, development, production, and decommissioning activities are analyzed in Section 4.3.4 and summarized in this section. First are the potential of habitat alterations due to disturbance of the benthic surface resulting from the volume and physical nature of materials (mud, sand, cobblestone, etc.) that are displaced by the actions of oil and gas discovery, development, and decommissioning activities. These activities would include anchoring of vessels and platforms, construction of infrastructure such as pipelines and subsea platforms, well drilling activities, and any similar activities that would disturb benthic surfaces. The disturbance of these surfaces and their effects are further defined by dispersal of materials through the water column (density of particles and residence time in the water column), and subsequent deposition on the benthic surface (area and depth of coverage of the benthic surface by displaced materials). Effects would include the temporary disruption of pelagic habitat by way of turbidity caused by suspended material. Disruption of habitat by way of covering benthic communities with sediment through deposition of suspended material downstream of disturbance sites would cause temporary loss of local benthic communities lasting from one year to four-eight years, depending on amount of material suspended and dispersal by way of local current patterns.

Habitat alteration could also include the possible introduction of marine invasive species by way of accidental introduction of biota. Transfer of materials and machinery from other areas to Chukchi Sea projects, and potential of bilge water contamination potentially lead to introduction of invasive species. Also possible is the advection of biota into the region by way of wind, waves, and energy from the movement of water masses across the Leased Area caused by the north Pacific and Siberian Sea currents and Arctic Ocean water through Hanna and Barrow canyons. Establishment of invasive lower trophic species could result in introduction of pathogens to current lower trophic and marine wildlife populations, and the possibility of introducing new species that may out compete and displace endemic species. Local disturbance to habitat and distribution of epontic species could be created by the actions of icebreakers.

A third direct effect is due to the net effects of discharges from vessels and platforms such as EPA NPDES-permitted discharges and non-point source pollution discharges from land such as villages and industry operation centers. These added contaminant sources could possibly lead to increased productivity of plankton blooms through increased nutrients or a change in seasonality of plankton blooms due to a more consistent source of nutrients.

A fourth effect is noise levels, their source and duration, as added from seismic work and all vessel and infrastructure activities. Transit of vessels, seismic operations, and addition of anthropogenic noise above ambient environmental levels may affect the recruitment and settlement patterns of larval invertebrates settling into adult habitats. However, no proven effects of noise greatly influencing invertebrate populations have been shown.

The effects of accidental spills and natural gas releases would be limited in time and space to localized populations near the source of the spill events. The sheer number of planktonic species and their various developmental stages advected into the Leased Areas, and the probable dispersal rates of small spills by evaporation and dispersal through wind and wave energy should prevent more than temporary and localized effects. This is due to the constant flow of wind and currents pushing nutrients, plankton, and larvae from the productive waters of the Bering Sea and Sea of Anadyr waters into the Chukchi Sea region by way of the North Pacific and Siberian currents.

Climate change and the resultant effects of warming air and waters, reduced ice cover, increased radiative input to surface waters, increased shoreline erosion and loss of peat bound ice, changes in seasonality of habitat, and increasing ocean acidification are factors that would affect lower trophic populations in the Leased Area. Through various interactions with all previously mentioned factors due to warming of both air and water temperatures in the region, and resultant increases in changes in the current environment, there could be affected changes in habitat and water chemistry and seasonality and territory of ranges of lower trophic populations during the projected 77 years of the Scenario. These potential changes inform the context for the analysis of cumulative impacts.

Cumulative effects may include the development of offshore oil production other than the Chukchi Sea Leased Areas (i.e. Canada and Russia development), onshore oil and gas production and subsequent construction and maintenance of infrastructure, onshore mining, and other similar activities such as trenching for telecommunication development. These activities would create further effects of discharges from nonpoint sources, sedimentary displacement and deposition, potentials for spills and natural gas releases, noise due to vessel traffic, and activities that could further increase cumulative effects on the Chukchi Sea Leased Areas.

5.2.3.2. Discussion of Other Relevant Actions

Other relevant actions include military activities, research activities, potential development of ports, added impacts from community development projects and tourism, and onshore mining projects. Military activities are difficult to define or quantitate due to governmental policies, particularly when considering potential increased presence in the Arctic of foreign government military presence. Addition of cumulative impacts from increases in air and marine vessel traffic, changes in population demographics due to increases in personnel, and potential of construction of infrastructure from increased activities would likely be minor additions when compared to those from industry activities. Research activities would likely remain relatively constant to past and present levels with cumulative additions likely due to longer open water seasons and changes in onshore hydrology. Construction of deepwater ports has been considered by the USACE in Nome, but considerations of the shallow coastal shelf waters combined with rapidly receding shorelines make these economically challenging. Impacts from community development projects may add nonpoint discharges and affect sedimentation near respective communities. Current onshore mining projects such as the Red Dog Mine are given various operational time frames, but environmental effects from these operations are unlikely to change during the foreseeable future.

All of the same factors external to offshore oil and gas exploration in the Leased Area that have affected lower trophic levels in the past are likely to continue in the future. Offshore oil and gas exploration and development is likely to increase in the U.S. Chukchi Sea and Arctic waters of other countries (i.e. Russia and Canada) as the ice cover recedes and allows access to previously inaccessible areas. These activities would add to the risk of ocean floor disturbance that impact lower trophic habitat across large areas. The continuation of offshore oil and gas exploration is expected to continue the accumulation of persistent contaminants from multiple sources and has the potential to affect lower trophic levels in the reasonably foreseeable future.

The influences of climate change on lower trophic levels arguably are of the most concern in cumulative effects analysis. In summary, the decrease of the extent of the Arctic ice pack impacts the epontic community, and subsequently, the pelagic and benthic communities. Warming ocean temperatures associated with climate change may increase all types of plankton growth rates and generation times in the region of the Leased Area, and change the composition of lower trophic populations as warmer seas, open water and increased radiative energy from the sun increases. The effects from oil and gas activity in the reasonable foreseeable future on lower trophic levels tend to be localized to areas near the activity, and so are geographically dispersed. Although the effects of climate change will be long-term, the effects that would occur in the life of the project are not expected to considerably impact lower trophic levels.

5.2.3.3. Analysis of Cumulative Impacts

The most influential impacts on lower trophic levels historically are from activities that disturb the ocean floor. Natural impacts of ice gouging, strudel scours, and the effects of loss of landfast ice on receding shorelines are most apparent. Past anthropogenic impacts have included the discharge of drilling muds and sediments from cuttings, bioaggregation and bioaccumulation from materials released during project activities, and habitat loss. Past and present actions that contribute to these disturbances include oil and gas development and exploration, and the introduction of persistent contaminants. Offshore production drilling activities in the Arctic have historically used systems such as artificial islands which directly impact the sea floor and have caused direct injury and mortality to lower trophic level organisms, and disturbance leading to habitat loss. In the Chukchi Sea specifically, it is reasonably foreseeable that future lease sales could lead to development requiring the installation of additional platforms and subsea pipelines, creating similar effects to the seafloor and lower trophic organisms. The historic discharge of cuttings also poses a threat to the benthic community’s habitat through deposition of artificial sediment on the benthic surface and temporary loss of benthic organisms. Mortality and injury is also caused by the introduction of toxins and sediments into the water column due to drilling discharges. These toxins may pose a threat to pelagic and benthic organisms. Studies show that habitat loss can also result from oil and gas exploration activities that require ice breaking efforts, forcing organisms to relocate. The effects from past and present actions on lower trophic levels tended to be localized to the areas near the activity, and so are geographically and temporally dispersed.

All factors both directly and indirectly related to offshore oil and gas exploration in the Leased Area that have affected lower trophic levels in the past are likely to continue in the future. Projected activities as outlined in the Scenario would add to the effects on these resources through both additive and synergistic cumulative impacts. Offshore oil and gas exploration and development is likely to increase in the U.S. Chukchi Sea and Arctic waters of other countries (i.e. Russia and Canada) as the ice cover recedes and allows access to previously inaccessible areas. These activities would add to the cumulative impacts of numerous ocean floor disturbances that affect lower trophic habitat across individual localized areas. The continuation of offshore oil and gas exploration and production is expected to further the accumulation of persistent contaminants from multiple sources and has the potential to affect lower trophic levels in the reasonably foreseeable future. Overall effects of cumulative impacts on lower trophic resources is considered to be minor due to the reproductive capabilities of most lower trophic organisms, and the constant movement and influx of nutrients and larval stages from advection caused by currents over the Bering Sea, Sea of Anadyr, and the Arctic Ocean.

5.2.3.4. Summary/Conclusion

The influences of climate change on lower trophic levels arguably are of the most concern in cumulative effects analysis. In summary, the change in seasonality and decrease of the extent of the Arctic ice pack directly impacts the epontic, pelagic, and benthic communities. The positive feedback loop of warmer water temperatures and open water that absorbs more radiative energy from the sun and increased absorption of carbon dioxide results in earlier spring ice and snowmelt, decreased ice thickness during the winter, changes in hydrology of onshore ecosystems, accelerated rates of coastal erosion and permafrost degradation, and changes in ocean chemistry. These cumulatively affect change in the composition of lower trophic populations as warmer seas, open water, and increased radiative energy from the sun create changes in energy levels and nutrients available for growth and reproduction of invertebrate species. Climate change is likely to affect the habitat, behavior, abundance, diversity, and distribution of populations of marine mammals, fish, and other wildlife within the Leased Area. The direct effects from the Proposed Action on lower trophic levels tend to be localized to areas near the activity, and so are geographically dispersed. Therefore, the contribution of all actions associated with the Scenario to the overall condition of lower trophic levels is minor.

5.2.4. Fish

5.2.4.1. Summary of Direct and Indirect Effects

Impacts to fish from the Proposed Action and alternatives are analyzed in detail in Chapter 4 and summarized here.

Noise and seismic emissions could ensonify fish habitat and negatively affect behavior, physical aspects, and physiological responses of fish species in the Leased Area across all depths, with various types of effects, and to varying degrees.

Wastewater discharges would affect fish and fish habitat dependent on the depths at which the waste is released into the water. Bottomwater discharges would cause injury and mortality to benthic-obligate fish life stages. Surface water discharges would negatively affect the behavior and physiology of surfacewater life stages of fish. Injury and mortality could occur to sensitive life stages exposed for a long period or repeatedly exposed to contaminants in a waste stream.

Seawater withdrawals would cause injury and mortality (impingement, entrainment) of eggs, larvae, age-0 fish, and weak-swimming small adults that pass through the hydraulic zone of influence of the intake structures. Young life stages in lakes, ponds, and rivers could also be injured through impingement and entrainment.

Habitat alteration of the seafloor would disturb, damage, and bury fish habitat, and sessile fish prey, resulting in mortality for individuals of some fish species unable to escape burial. Estuarine and freshwater bottom habitat could be disturbed through onshore construction activities.

Transit of vessels and seismic streamers would cause a path of physical disturbance, pressure waves from vessel hulls, cavitation bubbles generated by vessel hull structures, and vibrations from vessel pumps. Effects on early life stages in the surfacewater could include displacement, impingement, injury and mortality; effects on strong-swimming fish in the surfacewater would include interruption of ongoing behaviors. Ice breaking and ice management would disturb ice habitat which some fish species use for shelter and feeding.

Marine invasive species would be a potential risk that, if established, could affect fish habitat and fish in various ways including: encrusting native habitat, competing for food sources, competing for spawning grounds, preying on native species, or introducing pathogens. These effects could lead to changes in community structure, and shifts in abundance and diversity of native species.

Accidental small refined spills (<1,000 bbl) could affect behavior and physiology of sensitive life stages of fish species in localized areas of surfacewater which could lead to chronic or acute toxicity. Large spills would affect offshore and nearshore fish species in or near the path of oil through acute effects and long-term chronic effects. The effects would depend on several factors including life stage of fish species, distribution and abundance in water column or benthos, and timing of migrations and spawning.

Table 5-16. Arctic Climate Change Effects and Examples of Effects on Fish, Habitat, and Prey.

Climate Change Effects in the Arctic	Examples of Effects on Fish, Fish Habitat, and Fish Prey from Climate Change
Warming sea temperatures	Increase in metabolic rates of fish that affect growth rate and reproduction
Acidification of seawater (decrease in pH)	Eggs and early larval fish stages sensitive to increases in carbon dioxide levels and decreasing pH; dissolution effects on fish prey with calcium carbonate structure (e.g. pteropods)
Sea ice extent and thickness decreasing: increased sea surface exposed for accelerated warming of water; greater area for air-sea exchange of carbon dioxide; decreases in surface salinity	Decrease in sea ice habitat for fish that are associated with ice for feeding and shelter
Coastal erosion increasing	Nearshore spawning habitat altered by erosional sediment with less-preferred grain size (e.g. herring, capelin)
Aquatic invasive species, risk of introduction	Competition for food and habitat with native species
Warming pond temperatures – changes in surface area and levels (“drying”)	Reduced pond habitat area; increase in metabolic rates of fish
Melting permafrost – erosion of riverbanks and streambanks; changes in riparian vegetation and channel morphometry	Alteration of freshwater fish habitat and water temperature
Snowpack melt increasing - river discharge increase, sea surface water salinity decrease	Alteration of fish habitat velocities and depths

5.2.4.2. Discussion of Other Relevant Actions

The Proposed Action could add incremental impacts to the environment when added to other past, present, and reasonably foreseeable actions affecting the U.S. Chukchi Sea.

There are several types of actions that have occurred in the past, are currently occurring, or may occur in the foreseeable future that affect or would affect marine, estuarine, and freshwater fish, fish habitat, and fish prey over time in the U.S. Chukchi Sea (Table 5-17). These actions originate (or could originate) in the U.S. Arctic, Canadian Arctic, or the Russian Arctic.

Table 5-17. Other Actions Affecting Chukchi Sea, Anadromous and Migratory Fish Resources.

Actions that Could Affect Marine, Estuarine, and Freshwater Fish, Fish Habitat, and Fish Prey	Potential Types of Effects on Marine, Estuarine, and Freshwater Fish, Fish Habitat, and Fish Prey
Offshore oil and gas: (other than Lease Sale 193) Oil and gas exploration wells were drilled, decommissioned in the past; potential new exploration wells, new development and production wells, and new submarine pipelines	Seismic emissions and noise; Discharges; Bottom habitat disturbance; Water withdrawals; Risk of introducing aquatic invasive species; Small spills; Accidental large spills

Actions that Could Affect Marine, Estuarine, and Freshwater Fish, Fish Habitat, and Fish Prey	Potential Types of Effects on Marine, Estuarine, and Freshwater Fish, Fish Habitat, and Fish Prey
Commercial fishing: Currently commercial fishing is prohibited in the U.S. Arctic; commercial fishing is in U.S. Arctic is possible in the future. Commercial fishing currently occurs in Russian and Canadian Arctic	Noise; Discharges; Bottom habitat disturbance (trawling); Water withdrawals; Removal of fish from ecosystems; Risk of introducing aquatic invasive species; Small spills
Marine vessel traffic and anchoring; Global shipping vessels, oil and gas vessels, cargo vessels, military vessels, supply barges, cruise ships, commercial fishing vessels, survey vessels, research vessels	Noise; Discharges; Bottom habitat disturbance; Water withdrawals; Risk of introducing aquatic invasive species; Small spills
Offshore telecommunications Arctic submarine cable survey in U.S. Chukchi Sea and U.S. Beaufort Sea in 2014; seafloor trenching and cable laying in 2015, with a landfall in Prudhoe Bay cables	Sonar and noise; Discharges; Bottom habitat disturbance; Water withdrawals; Risk of introducing aquatic invasive species; Small spills
Onshore oil and gas; Exploration, development, production, and decommissioning; Wells drilled at Prudhoe Bay, Kuparuk, Alpine, Greater Mooses Tooth, and other sites on North Slope; onshore pipelines and access roads.	Seismic surveys and noise; Discharges; Bottom habitat disturbance (freshwaters); Water withdrawals; Risk of introducing aquatic invasive species; Small spills
Onshore construction and maintenance; Projects developed by community, industry (other than oil and gas), Federal and state governments, and military entities. Ports, docks, roads, gravel pads, bridges, runways, ice roads, energy projects, wastewater plants, etc.	Noise; Marine vessel traffic; Discharges; Bottom habitat disturbance; Water withdrawals; Risk of introducing aquatic invasive species; Small spills
Onshore mining; Hardrock mining; gravel mining; coal mining; placer mining, and associated road and facility construction and maintenance; Red Dog hardrock mine, road, and port since 1986; potential Ambler Mining District and Upper Kobuk Mineral Project; potential coal mining projects in Brooks Range; historic placer mining on Seward Peninsula	Noise; Marine vessel traffic (at ports); Discharges; Bottom habitat disturbance; Water withdrawals; Risk of introducing aquatic invasive species; Small spills
Climate change (Not an action, but included in cumulative effects analysis).	Climate change affects the other actions described in this table through various pathways.

Notes: Types of Actions (Other than the Proposed Action) That Could Affect Fish, Fish Habitat, and Fish Prey Over Time (Past, Present and Reasonably Foreseeable Future) in the U.S. Chukchi Sea and Associated Anadromous and Migratory Waters.

5.2.4.3. Analysis of Cumulative Impacts

Reduction in the extent and duration of sea ice may increase the potential for commercial fishing in the U.S. Arctic; however, under the Arctic Fishery Management Plan, commercial fishing is currently prohibited in the U.S. Arctic (north of Bering Strait). If commercial fishing were permitted in the future, it would likely be managed by NMFS.

Several studies have examined the effects of climate change (including ocean acidification) on commercial fisheries. These studies emphasize: the implications of decreasing Arctic sea ice; potential range expansions of fish species into the Arctic; the effects of warming sea surface temperatures on fish biomass; possible changes in fish species complexes; effects on commercially important calcareous species; shifts in prey available and shifts in food webs; and the particular vulnerability of coastal areas in Alaska (AMAP, 2013; Cheung et al., 2009; Mathis et al., 2014; Mann et al., 2013; Sherman et al., 2009).

The primary effects of commercial fishing would be the removal of fish from the ecosystem along with potential disturbances and contamination from the presence and operation of commercial fishing vessels. Oil and gas platforms could potentially provide a different type of structural habitat for fish; this could positively or negatively affect commercial fishing depending on the commercial species targeted. It is noted that some structural remains from oil and gas operations in other parts of the U.S. have been considered for essential fish habitat designation to rebuild certain stocks of fish.

Fish in the Chukchi Sea and nearshore areas could be affected by increasing vessel traffic from global shipping vessels, oil and gas vessels, cargo vessels, military vessels, supply barges, cruise ships, commercial fishing vessels, survey vessels, and research vessels. Increased shipping increases the occurrence of small spills, the risk of introducing aquatic invasive species, and the possibilities of oil spills or vessel groundings, all of which would affect fish, fish habitat, and fish prey.

Installation of offshore telecommunications cables would cause additional bottom habitat disturbance from surveying (current), trenching, and laying fiber optic cable (foreseeable future) north through the Chukchi Sea to Prudhoe Bay and northeast through the Canadian Arctic.

Onshore development and mining activities, to include associated construction and maintenance projects and facilities, would affect fish, fish habitat, and fish prey via stream, pond, and lake habitat alteration; water withdrawals; permitted discharges; construction of support facilities; construction of roads, ice roads; and construction of pipelines.

5.2.4.4. Summary/Conclusion

There are a variety of other activities that will result in discharges, habitat disruption, or otherwise impact fish. The Proposed Action would contribute minor to moderate impacts to fish in addition to the impacts from past, present and reasonably foreseeable actions noted in Table 5-2.

5.2.5. Marine and Coastal Birds

5.2.5.1. Summary of Direct and Indirect Effects

The Proposed Action would include activities that could impact Marine and Coastal Birds. Effects from the physical presence and noise from vessels/ aircraft/drilling facilities, underwater noise, discharges, habitat alteration, and small spills are localized and would not persist from season to season. Mortality from birds encountering vessels, drillships, and platforms, however, could exceed 1,000 birds per season and are anticipated to result in a major level of effect.

5.2.5.2. Discussion of Other Relevant Actions

There are a variety of factors that influence populations of Marine and Coastal Birds in the Chukchi Sea. Anthropomorphic impacts in the past and present include disturbance, lead poisoning, collisions, hunting, and predation. For example, birds can ingest lead shot and die from poisoning. Birds collide with vessels and other structures and are killed. Birds have experienced increased predation from introduced foxes and rats on their breeding grounds. The reasons some species (e.g., spectacled eiders, Steller’s eiders) have experienced substantial population declines in the past remain elusive. The effects from past and present actions on Marine and Coastal Birds tended to be low-level, but were persistent and widespread. Some of these factors have somewhat abated and some populations have stabilized, but at a lower level.

In the absence of the Proposed Action, the activities that produce these effects on Marine and Coastal Birds are still present, and are resulting in disturbance, habitat alteration, reduced productivity, and mortality. For this reason, past and present actions are causing a minor impact on Marine and Coastal Birds.

Reasonably foreseeable future actions and events are detailed in Tables 5-4 through 5-12. As the ice cover melts earlier and forms later, there is greater access to previously inaccessible areas. The same IPFs associated with offshore oil and gas exploration in the Leased Area that have affected Marine and Coastal Birds in the past are likely to continue in the future. The effects of routine oil and gas exploration and development that may occur in the Chukchi and Beaufort seas, on the North Slope, and in bordering countries (i.e. Russia and Canada), together with increased recreation/tourism/hunting, fishing and regular commerce and transport, would increase the physical presence and sound disturbances from vessel and aircraft traffic, increase underwater noise, create more discharges/habitat alteration, and likely increase the number of small spills. These activities, however, are anticipated to be widely dispersed.

The greatest source of harm to Marine and Coastal Birds associated with reasonably foreseeable future actions and events are from bird encounters with vessels, platforms, and other structures. The increased number of vessels and platforms in and around the Chukchi Sea would likely increase the potential for bird-vessel encounters and the numbers of birds killed in these encounters. While the number of transits are projected to double, there is not a direct relationship between number of transits and bird encounters. Some of the transits are brief (round trips measured in days) as these vessels make their delivery/pick-up and then depart. The bird encounter rate(s) are based on activity of each vessel or platform during an entire open water season. There are two more reasons that the realized mortality may be relatively low: 1) some of the species described in the affected environment are at the margin of their distributions, with fewer of the population to the west (Russia) and east (Canada), and 2) all of the projected future activity would not likely be concentrated near the coastline, where bird population densities are highest. In the absence of the Proposed Action, the number of Marine and Coastal Bird mortalities from encounters with vessels would likely be considered a moderate level of effect.

The influences of climate change on Marine and Coastal Birds remain difficult to predict as some bird species could benefit from a new variety or pattern of habitats. Similarly, some may benefit from the northward expansion or changes in prey distribution and abundance. Some species would not benefit from these changes or may be adversely impacted by them. For example, birds that depend on sea ice for some portion of their annual cycle would be negatively impacted by climate change. Which species fall into which category cannot be projected with any reliability at this time.

5.2.5.3. Analysis of Cumulative Impacts

As stated above, Marine and Coastal Birds in the Leased Area have been exposed to activities that have impacted them in the past. The activities that produce these effects are still present and are resulting in disturbance, habitat alteration, and mortality to Marine and Coastal Birds. The effects of past and present actions on Marine and Coastal Birds are thought to be minor.

The effects of routine oil and gas exploration and development activities that may occur in the Arctic waters of the Beaufort Sea, as a result of future BOEM and State of Alaska lease sales, and bordering countries (i.e. Russia and Canada) as well as increased recreation/tourism/hunting, fishing, and regular commerce and transport, would increase the physical presence and sound disturbances from vessel and aircraft traffic, increase underwater noise, create more discharges/habitat alteration, and likely increase the number of small spills. These activities, however, are anticipated to be widely dispersed and short-term, and thus would have effects that range from negligible to minor. A large source of harm to Marine and Coastal Birds associated with reasonably foreseeable future actions and events are from bird encounters with vessels, platforms, and other structures. The increased number of vessels and platforms in and around the Chukchi Sea would likely increase the potential for bird-vessel encounters and the numbers of birds killed in these encounters would increase. In the absence of the Proposed Action, the number of Marine and Coastal Bird mortalities from encounters with vessels would be considered a moderate level of effect.

The Proposed Action would include activities that could impact Marine and Coastal Birds. Effects from the physical presence and noise from vessels/ aircraft/drilling facilities, underwater noise, discharges, habitat alteration, and small spills are localized and would not persist from season to season. Mortality from birds encountering vessels, drillships, and platforms, however, could exceed 1,000 birds per season and are anticipated to result in a major level of effect. The Proposed Action, when added to reasonably foreseeable future effects and actions, would result in a major level of effect.

5.2.5.4. Summary/Conclusion

The Scenario for the Proposed Action details how offshore oil and gas exploration and development may occur in the U.S. Chukchi Sea, with impacts to Marine and Coastal Birds anticipated to result in a major level of effect. The Proposed Action, when added to reasonably foreseeable future effects and actions, would result in a major level of effect. The Proposed Action would be the primary driver of effects to this resource over the life of the Scenario, particularly to spectacled eiders, king and common eiders, and seabirds, including the short-tailed shearwater, and common and thick-billed murres.

5.2.6. Marine Mammals

5.2.6.1. Summary of Direct and Indirect Effects

The effects of the Scenario are analyzed in Chapter 4 of this document and are summarized below in Table 5-18.

Table 5-18. Lease Sale 193 Effects that May add to Incremental Effects on Marine Mammals.

Marine Mammal Species	Effects from Chapter 4
Beluga Whale	Minor
Bowhead Whale	Moderate
Fin Whale	Negligible
Gray Whale	Moderate
Harbor Porpoise	Negligible
Humpback Whale	Negligible
Killer Whale	Negligible
Minke Whale	Negligible
Bearded Seal	Moderate
Ribbon Seal	Negligible
Ringed Seal	Moderate
Spotted Seal	Negligible
Pacific Walrus	Moderate
Polar Bear	Negligible

The Proposed Action would include activities that could impact marine mammals. Effects from the physical presence and noise from vessels/ aircraft/drilling facilities, underwater noise, discharges, habitat alteration, and small spills are localized and would not persist from season to season. The greatest effect on cetaceans would arise from unmitigated vessel traffic during production which would likely result in vessel strikes, especially to migrating gray and bowhead whales, elevating the overall effects from negligible-minor to moderate due to a low number of potential mortalities from vessel strikes to cetaceans. For ringed and bearded seals, the greatest effector would be winter spills which could trap oil or condensate under ice or in lead systems, producing some mortalities among seals overwintering. Humpback and fin whales remain rare in the vicinity of the Leased Area and their low numbers would preclude any serious potential of ship strikes occurring to these species.

Polar Bears

Most of the activities associated with the phases of the Proposed Action occur in open water. Polar bears are found primarily in the pack ice and few bears would be likely to overlap in time and space with open water activities. In the development and production phases of the Proposed Action, permanent infrastructure would be put in place in the offshore (platforms) with pipelines running ashore and onshore infrastructure for processing, housing staff, and other associated purposes. Polar bears may move through the oil field and near the platforms onshore in the open water season and offshore during the ice season. The primary effects on polar bears of the activities described in the Scenario would be an increase in the potential for bear- human interactions at developed sites and during exploration activities taking place on ice in areas where bears may be present. An increase in interactions could result in increased energetic costs to individual bears as they are hazed away from areas of human activity. This could also potentially result in the necessity for lethal take of some bears to protect humans, although to date, very few bears have been taken in defense of human life due to oil industry activities on the North Slope. Exploration activities and development of offshore infrastructure may displace seals and walrus, resulting in some displacement of foraging polar bears. Bears may also be displaced from some coastal and barrier island areas, though bears do not use the Alaskan coast of the Chukchi Sea as consistently as the Beaufort Sea or the Russian coast of the Chukchi Sea.

Pacific Walrus

The primary effects to walrus from the Proposed Action are disturbance related. Walrus may be disturbed by noise associated with seismic operations, by vessels, air traffic, or drilling operations. Walrus may be displaced from preferred foraging habitat by industry activities. Walrus on ice or at terrestrial haulouts may be disturbed while resting, resulting in additional energetic costs and in some cases injury or death from trampling. Though less common, walrus could also be struck by ships or suffer prop injuries from vessels, particularly when in ice-infested waters.

Indirect effects to walrus are primarily prey related. Walrus forage on benthic invertebrates which may be buried, resulting in mortalities during any operations that disturb the seabed. During the exploratory phases these would include exploratory drilling, well cellar placement, BOP placement, anchoring, and other activities. During the production phase, activities that would disturb the seabed and result in loss of foraging habitat and prey items would include building platforms, placing templates, burying pipelines and the activities previously listed above.

Additional impacts to walrus could occur from ice breaking activities that reduce the size or amount of sea ice available for walrus to haul out on, particularly in the vicinity of the HSWUA.

5.2.6.2. Discussion of Other Relevant Actions

Oil and Gas Activities

Oil and gas activities could have minor to moderate effects on marine mammals in and around the Leased Area, mostly through vessel traffic and elevated noise levels that could prove deleterious to individual animals. Since the early 1900s, oil and gas exploration have occurred on the North Slope and development and production since the early 1970s. More recently, exploration has occurred on the OCS and in onshore areas within the NPR-A. In the 1980s, exploration activities were conducted in the Beaufort Sea, and in 1989 and the early 1990s, an oil and gas operator conducted exploration activities in the Leased Area, with no residual effects on marine mammals in the area. Presently, there are plans to bring the Liberty project into production in the Beaufort Sea, and the Greater Mooses Tooth project in the NPR-A. Concurrent with recent oil and gas exploration and development activities in the U.S., both Canada and Russia are engaged in offshore exploration and development projects in the eastern Beaufort and Siberian Sea respectively.

In addition to exploration and field development, the State of Alaska and industry are investigating the feasibility of constructing a natural gas pipeline from Prudhoe Bay to south-central Alaska with possible spurs to fuel communities near the pipeline route.

Future oil and gas activities in the Chukchi Sea would likely concentrate in the vicinity of the Leased Areas. Likewise, Canada and Russia are expected to develop their offshore oil and gas resources to the fullest extent possible. In preparation for future oil and gas activities and developments, Russia has been actively upgrading and creating support infrastructure along their Arctic coastline. Gearon et al. (2014) modelled the spread of spills originating in the Eastern Beaufort Sea, and found that oil from a theoretical 5.4 million bbl well blowout could contact some Beaufort and Chukchi Sea nearshore areas. Such events would be highly unlikely considering the geology, reservoir sizes, water depths, and pressures involved. Spills originating in the Siberian Sea affect resources in the Leased

Area, though, if spills in Canada or Russia were large enough to induce marine mammals in those areas to disperse to other areas that could include the Leased Area.

Economic Development

The effects of economic development would include increased financial resources which could provide subsistence hunters with more fuel and more or better equipment for subsistence activities, leading to increased levels of subsistence hunting. Consequences of increased levels of subsistence activity would include increased noise from greater small vessel use in the Chukchi and Beaufort Seas.

Increased affluence in Canadian communities along the Beaufort Sea should have little, if any, effect on most marine mammals in the Leased Area. Canadian subsistence hunters would likely increase subsistence activity levels, which could affect bowhead whales, bearded seals, ringed seals, and the spotted seal or walrus. Russian subsistence levels in Siberian and Chukchi Sea communities could experience economic benefits from oil and gas production in the Siberian Sea, but not from activities occurring in North America. Chukotkan and Siberian subsistence hunters would also increase their harvests of bearded seals, ringed seals, gray whales, and perhaps Pacific walruses; however, such harvests would not be noticeable at a population level.

In the long term, the harvests of some marine mammal species should decline in tandem with the effects climate change has on populations of ringed seals, polar bears, and walruses; however, harvests of other species such as ribbon seals, spotted seals, and gray whales could increase if greater proportions of their populations shift north in response to more suitable climatic and oceanic conditions.

Recreation and Tourism

The opening of Arctic waterways connecting the Beaufort Sea with the western Atlantic Ocean and the Chukchi Sea with eastern Atlantic Ocean has allowed a tourism industry to develop in recent years and levels are expected to increase in the future. Such tours involve cruise ships which produce noise and discharges, as well as onshore activities including sport hunting, sport fishing, wildlife viewing, photography, and adventure activities. Sport hunting and fishing could produce moderate effects on some wildlife and fish populations since individuals are harvested, but population level effects are not anticipated. In comparison, activities such as wildlife viewing, and adventuring do not typically impact wildlife population. The overall effects of recreation and tourism on marine mammals are expected to be moderate due to mortalities associated with recreational hunting and fishing.

Marine Vessel Traffic

Vessel traffic in the marine environment is associated with subsistence hunting, travel between coastal communities, commerce, tourism, research, oil exploration, and some military activities.

In 2012, 96 commercial vessels navigated from the Chukchi Sea to the Barents Sea via the Northern Sea Route, while cruise ships and other recreational vessels successfully travelled the Northwest Passage. Between 2008 and 2012, the estimated annual number of vessels transiting the Bering Strait increased from 220 to 480, and will continue to increase to around 1,000 vessels per year by 2025 if current projections hold.

Ship and boat activity supporting oil exploration and development mostly occurs within the Leased Area; along lengthy track lines in the case of seismic surveys, and in marine waters between onshore locations and offshore project sites. In comparison, boat and vessel traffic to transport people between communities and for subsistence purposes usually occurs in coastal areas and could only affect marine mammals in coastal waters. The amount of vessel traffic passing through the Bering Strait and into the Chukchi Sea has been increasing in recent years (Clarke et al., 2014) and may continue to increase into the foreseeable future, potentially adding more noise into the marine environment and increasing the risks of strikes to marine mammals.

Aircraft Traffic

Aircraft traffic has been increasing across the North Slope in recent years, mostly in support of commercial, government, academic, and military activities. Recently, a growing number of aircraft have become associated with recreational activities, and these numbers should continue to grow into the future, although such flight activity would occur over onshore areas. Similarly, commuter and emergency flight activity continues to grow. Though increases in onshore air traffic are occurring, the increases remain proportionately low with respect to existing air-traffic levels.

Aircraft use over the Leased Area and other portions of the Chukchi Sea are typically performed by oil exploration companies, and by government entities who conduct surveys such as ASSAM, BOWFEST, etc. Assuming exploration, development, production, and decommissioning occur, air-traffic levels within the Leased Area and between the Anchor Field, Satellite Field, and the coast would increase substantially and likely occur year-round, rather than seasonally.

Negligible to minor effects to marine mammals would occur if aircraft altitudes drop below 1,500 feet or if aircraft approach marine mammals too closely laterally.

Subsistence

Thousands of seals are harvested annually in subsistence hunts, along with many other marine mammals that include bowhead whales, beluga whales, Pacific walruses, and polar bears. Numbers of animals harvested varies by community and hunting areas typically radiate out from each community for many miles. Consequently, each community represents a particular subsistence area, and no two are exactly alike. The animals occurring in such areas are likely to be more skittish than those animals occurring elsewhere, and disturbance events could elicit more overt reactions from marine mammals in such areas.

Scientific Research

The effects of existing research-oriented aircraft traffic and vessel traffic on marine mammals have been covered and generally occur during the open water season (July-October). Another type of survey activity is on-ice research that usually occurs in winter and early spring, but may also occur on pack ice during the open water season. These activities are limited in the amount of disturbance they produce, due to the small footprint of their operations, the limited amount of potential disturbance created, and the limited duration and magnitude of fieldwork.

Studies conducted in the OCS tend to be non-invasive for marine mammals with negligible levels of effect, and include activities such as radio-tagging, aerial observations, etc.

Mining

The Red Dog mine is located in the western Brooks Range near the Chukchi Sea coast, and is the world’s largest zinc mine. Other mineral mines are proposed for the western Brooks Range, and a coal mine may open in the near future near the Chukchi Sea coast. Development of the proposed mines remains contingent upon creating a spur road from the Dalton Highway to the Ambler Mining District and from there to the Red Dog mine and potentially the Seward Peninsula.

Barring unforeseeable accidents, it is unlikely mining itself would have any identifiable effects on marine or terrestrial mammals; however, road creation and the vehicular, air, and vessel traffic associated with such mines would produce negligible to moderate levels of effects on individual animals.

Military

Aside from cold-war submarine operations under sea ice, there has been very little military activity in the Chukchi and Beaufort Seas. Sea ice extent and distribution has always been a great obstacle to U.S. Navy (USN) and U.S. Coast Guard (USCG) activity in these areas, and will continue to be – albeit to a lesser degree - in upcoming decades. The USCG icebreakers HEALY and POLAR STAR are the only U.S.-flagged vessels capable of breaking ice in the Chukchi Sea (Riddle, 2014).

The burgeoning interest in the Arctic has the U.S. Navy exploring available options for suitable deepwater ports and airstrips with access to Arctic waters in Alaska. No final decisions have been finalized or publicized; however, the recent Russian military build-up along their Russian Arctic coast may precipitate similar actions by the USN (Climate Change Task Force, 2014; Titley and St. John, 2010).

Climate Change

Climate change in the Arctic is the driving factor behind increasing vessel traffic, air traffic, military activity, and economic development. It is also expected to have the greatest effects on Arctic marine mammals. The direct and indirect effects of climate change on marine mammals include primary and secondary changes to ecological processes that mammalian species depend on for life. Some such changes could be partially beneficial to certain species of marine mammals while detrimental to others, depending on what life processes are affected for a species and the manner in which those effects occur.

Increasing temperature should lead to increased sea ice losses, increased glacial ice melt, earlier and faster snowmelt, extended growing seasons, and shortened winters. Likewise, the summer and winter air and water temperatures will increase, along with the amount of precipitation. These effects of climate changes, when combined, could have major impacts in the marine, coastal, and terrestrial environment of Alaska, and could affect every living organism to one degree or another.

Melting permafrost can also create melt ponds and lakes on tundra in low lying areas. Such catchments of soil moisture are unlikely to directly flow into streams and may be ephemeral. Rivers and streams along the Arctic Coastal Plain (ACP) would also experience impacts from changes to the climate with earlier episodes of spring flooding (Nghiem et al., 2014; Beltaos, 2013; Queenie et al., 2012) followed by decreases in groundwater inputs derived from melting snow, ice, and permafrost (Qiu, 2012). Spring and summer flooding of river systems can lead to large influxes of warmer freshwater into the Arctic marine environment. If such events occur in a rapid surge as opposed to a steady inflow, extensive areas of sea ice can rapidly melt (Nghiem et al., 2014).

Sea ice losses in the Arctic Ocean may lead to larger storms, resulting in larger waves that would weather away coastlines and islands more rapidly (Vavrus, 2013). Such events could result in larger and more frequent storm surges reaching farther inland from the coast. Storms and storm surges, along with warming air, would facilitate the thawing of permafrost in Arctic soils and increase the annual depth of thawed soils (Kittel, Baker, Higgins, and Haney, 2011; Vavrus, 2013), leading to the release of soil organic matter into watersheds. Nearshore areas of the Beaufort and Chukchi Seas would receive larger surges of organic influxes from eroding coastlines, streambanks, and from the thawing permafrost that would add organic constituents to the marine food web.

Ocean acidification would continue as a result of climate change, and would affect the levels of calcium carbonate available to invertebrates for shell development. Under such conditions, benthic creatures such as bivalves and polychaete worms would have difficulty creating and maintaining shells, while species such as jellies, squid, etc. might flourish. At the microbial level, blue-green algae could have trouble creating the calcium carbonate matrices needed to permit them to remain near the surface of the ocean, and such a situation could have severe repercussions throughout the oceanic food web (Raven J. et al., 2005; Riebesell and Tortell, 2011).

Both summer and winter temperatures are expected to increase across the NPR-A in northwestern Alaska through this century, with the greatest changes occurring in winter. Average winter temperatures are likely to increase by as much as 18°F (10°C) by the 2090s, rising well above 0°F (18°C), as compared to historical averages of almost ten below (-23°C), while summer temperatures are projected to rise by about 3°F (1.7°C) by the 2040s, and 5–6°F (2.8-3.3°C) by the 2090s (Scenarios Network for Alaska and Arctic Planning, 2011). Precipitation patterns are also expected to change with 20-45% increased winter precipitation by the 2040s, and 35-70% increases in the 2090s; while summer precipitation increases would be smaller. A northward shift in thaw dates is expected over the course of the century with thawing occurring in the coastal regions during the first week of June by mid-century and June 1 by the end of the century; while thaws would occur around May 1st in the southern NPR-A. In comparison, fall freeze-up dates along coastal areas would extend into late September, and October 1st in the Brooks Range.

5.2.6.3. Analysis of Cumulative Impacts

Beluga Whale

Beluga whale populations exist in other ice-free waters off of Alaska, so it is likely that they could exist in an ice-free summer arctic; therefore, shrinking sea ice could draw beluga whales farther north with the ice front, away from the Leased Area. They will continue feeding on appropriate fish species so long as those stocks remain abundant. Once existing prey stocks decline, belugas would likely switch to other prey species that become available. Hypothetically, a total loss of sea ice over the Arctic Ocean during the summer months would permit different beluga and narwhal stocks to mingle; it may also permit predators such as transient killer whales to more efficiently hunt belugas since belugas are believed to swim under and through ice floes to avoid killer whales. Due to their dispersal across the Chukchi and Beaufort Seas, particularly areas beyond the continental shelf break, belugas would not be impacted by most of the effects of oil and gas development short of a VLOS.

It is assumed that later in the 21st century as summer sea ice recedes north there would be no need for icebreaking during the July-October period. Though the ice-free season would likely extend out a few weeks from present dates, there are no known oil or gas reserves under the deep waters of the Arctic Basin where most belugas would be concentrating. Consequently, the effects of icebreaking on beluga whales should decrease into the future due to a decreasing need for such activities.

As summer sea ice recedes, shipping lanes are likely to open and commercial vessel traffic could easily pass through beluga whale habitat. Belugas are expected to remain safe from most commercial vessel traffic through detection and avoidance, just as they have done in other areas of the world. Vessel traffic associated with scientific surveys is likely to increase throughout the Chukchi and Beaufort Seas in the future; however, belugas should be capable of avoiding survey ships just as they would commercial vessels. Vessels associated with military operations could include surface ships and submarines. Submarines are capable of operating under sea ice just as they have in the past, but their presence could become more common in the future as military activities increase in the Arctic.

Other military activities could include aircraft operations using jets and helicopters, in addition to the types of aircraft that are normally used on the North Slope. Jets often operate at supersonic speeds which introduce much more noise into the environment than propeller-based aircraft, and helicopters create a different type of noise disturbance than fixed wing aircraft. Given these potential disturbances, some level of habituation to aircraft noise may be necessary for beluga whales.

Positive changes in the economic conditions among subsistence-dependent people may permit extended hunting forays that travel greater distances and remain in the field for longer periods of time. A potential effect of increased hunting pressures would be larger harvests, and hunts occurring in places that were previously relied upon as safe refuge areas by belugas, which would add additional stresses to beluga stocks.

Climate change effects to the Chukchi and Beaufort Seas would have a greater impact on beluga whale numbers, distribution, and population viability than all of the past, present, and foreseeable human activities combined. The effects of the Proposed Action on beluga whales would not appreciably add, or synergistically interact with other past, present, or reasonably foreseeable future activities, or climate change, to alter the condition of beluga whale stocks in the 21st century.

Bowhead Whale

Through much of the 21st century, bowheads may experience positive effects from climate change with increased productivity and longer open water seasons. Towards the end of the 21st century, earlier melts of sea ice in spring could permit bowhead whales to migrate a few weeks earlier. Hypothetically, a total loss of summer sea ice over the Arctic Ocean would permit different bowhead whale stocks to mingle; however, it would also allow predators such as transient killer whales to more efficiently hunt bowheads since bowheads often swim under heavy ice cover where killer whales cannot follow. Climate change effects in the Chukchi and Beaufort Seas would have a greater impact on bowhead whale numbers, distribution, and population viability than all of the past, present, and foreseeable human activities, including the Proposed Action, combined.

Increasing vessel traffic in the Arctic would no longer be restricted to the Northwest Passage or the Northern Sea Route, which is presently open for limited periods of time. For bowhead whales, the consequences of prolonged ice-free Arctic waters would be more large commercial and tourism vessels passing through their feeding grounds in the Eastern Beaufort, Barrow Canyon, and off the coast of Chukotka. This could impact bowhead whales passing through the Bering Strait during spring or fall migrations if the migrations get out of synchronization with the fall formation and spring melt of sea ice in the northern Bering and southern Chukchi Seas. The effects of the additional vessel traffic could include increased vessel strikes of bowhead whales, and increased noise production into the marine environment. Increased military and Coast Guard activity would mostly include seasonal patrols of U.S. Navy and Coast Guard ships during the open water season, some submarine activity throughout the year, and aircraft operations from bases onshore and possibly carriers towards the end of the 21st century. In an ice-free summer Arctic, the possibility of fielding an aircraft carrier becomes more plausible since there would be no additional risks to such a vessel. Under such conditions there would be no need for icebreaking during the July-October period, and the use of icebreakers would decline. Commercial vessel traffic is the human activity likely to have the greatest effect on bowhead whales, through vessel strikes.

Other forms of vessel traffic include support for scientific surveys, which are likely to increase into the future, along with subsistence activities. Bowhead whales should remain capable of avoiding survey ships. Small watercraft used for subsistence, particularly whaling, may operate for longer periods of time due to increased financial resources among some subsistence users. Weather and sea ice have profound effects on whaling in the Arctic. If summer Arctic waters become ice free, bowhead fall migrations may shift north, beyond the reach of subsistence whalers. With larger, more frequent and powerful storms expected to occur in the Arctic Ocean as the 21st century progresses, people engaged in whaling in open water could be at a greater personal risk. Moreover, stormy weather may shorten the time available for whaling activities or make subsistence whaling unfeasible.

The effects of the Proposed Action on bowhead whales would not appreciably add to or synergistically interact with other past, present, or reasonably foreseeable future activities to alter the condition of the Western Arctic Bowhead Whale stock in the 21st century.

Fin Whale

Earlier and more extensive summer sea ice losses in the Beaufort and Chukchi Seas would affect fin whales by opening up more habitat for them to occupy. As the marine environment shifts towards a more pelagic system, fish production would become more favored over benthic production. Fin whales feed on fish and larger fish stocks would be favorable to them. When the Arctic Ocean becomes ice free during the summer, fin whales from the North Atlantic and the North Pacific may mix. Consequences of those interactions are speculative, but could include disease transmission, competition, and interbreeding. The lack of a commercial fishery in the U.S. Chukchi and Beaufort Sea would also favor an increasing presence of lunge-feeding mysticetes whale species such as fin whales. Climate change effects in the Chukchi and Beaufort Seas would have a greater impact on fin whale numbers, distribution, and population viability than all of the past, present, and foreseeable human activities combined.

Summer sea ice losses in the Arctic Ocean would also permit increasing numbers of commercial, tourism, and scientific vessel activity. As the Northwest Passage and Northern Sea Route remain clear of ice for longer periods of time, more vessels are likely to ply the Chukchi Sea, enroute to Asian and American markets. The growing numbers of commercial vessels would increase the likelihood of striking fin whales and introduce more sound into the marine environment. The numbers of scientific and industry survey vessels in the Chukchi and Beaufort Seas are also likely to increase along with the noise they produce. Because an increase in military and USCG activity in the Chukchi and Beaufort Seas is anticipated, U.S. Navy and Coast Guard vessel presence in the Chukchi and Beaufort Seas is also likely to increase.

Commercial, military, and scientific aircraft operations are expected to increase into the foreseeable future. Greater use of military jets and helicopters would introduce more noise, though most military aircraft usually maintain an altitude of several thousand feet above the water or land surface which minimizes the disturbance to the marine environment. Scientific surveys using aircraft such as the ASAMM, BOWFEST, BWASP, etc. fly at altitudes sufficient to negate most transfer of sound into the water. Throughout the 21st century, aircraft operations should have negligible effects on fin whales.

Climate change effects to the Chukchi and Beaufort Seas would most likely have a positive effect on fin whales; one that is greater and more profound than all of the past, present, and foreseeable human activities combined. The effects of the Proposed Action on fin whales would be negligible and would not appreciably add to, subtract from, or synergistically interact with other past, present, or reasonably foreseeable future activities, or climate change, to alter the condition of fin whales in the Chukchi Sea during 21st century.

Gray Whale

Earlier and more extensive sea ice losses during the summer months in the Beaufort and Chukchi Seas would affect gray whales by opening up more habitat for them to occupy, particularly in the Northern Chukchi Sea. As the marine environment shifts towards a more pelagic system, fish production would become more favored over benthic production. Gray whales feed on benthos, and larger fish stocks may be less favorable for them; however, some gray whales remain in the Bering Sea and near Washington State and British Columbia, feeding on fishes and invertebrates during summer. Such differences can be explained as generalist feeding behavior that permits gray whales to exploit the most easily obtainable food resources; feeding flexibility is also likely considering the maneuverability of gray whales which has been theorized and documented (Pyenson and Lindberg, 2011; Woodward, Winn, and Fish, 2006). When the Arctic Ocean becomes ice free during the summer, gray whales from the North Pacific may venture into the Atlantic Ocean as has been documented twice since 2008, potentially recolonizing certain areas. Climate change effects in the Chukchi and Beaufort Seas are likely to have a positive, greater, and more profound impact on gray whale numbers, distribution, and population viability than all of the past, present, and foreseeable human activities combined.

Sea ice losses in the Arctic Ocean would also permit increasing numbers of commercial, tourism, and scientific vessel activity, as described above, in the section on fin whales. Growing numbers of commercial vessels would increase the possibility of striking gray whales, particularly in nearshore areas, and would introduce more sound into the marine environment. The numbers of scientific, industry, and military vessels, (potentially including submarine and aircraft carrier operations), in the Chukchi and Beaufort Seas are also likely to increase along with the noise they introduce into the environment.

Effects of increasing aircraft traffic on gray whales are similar to those described above for fin whales; aircraft operations should have negligible impacts on gray whales.

Climate change effects to the Chukchi and Beaufort Seas would most likely have a positive effect on gray whales; one that is greater than all of the past, present, and foreseeable human activities combined. The effects of the Proposed Action on gray whales would not appreciably add to, subtract from, or synergistically interact with other past, present, or reasonably foreseeable future activities, or climate change, to alter the condition of gray whales in the Chukchi Sea during 21^{st} century.

Harbor Porpoise

Earlier and more extensive sea ice losses during the summer in the Beaufort and Chukchi Seas would affect harbor porpoises by opening up more habitat for them to occupy, particularly in the Northern Chukchi Sea. As the marine environment shifts towards a more pelagic system, fish production would become more favored over benthic production. Harbor porpoises feed on fish, and larger fish stocks would be more favorable for them. If the Arctic Ocean becomes ice free, harbor porpoises from the North Pacific may mix with harbor porpoises in the Atlantic Ocean, though consequences of such mixing remain speculative. Climate change effects in the Chukchi and Beaufort Seas are likely to have a positive, greater, and more profound impact on harbor porpoise numbers, distribution, and population viability than all of the past, present, and foreseeable human activities combined.

Sea ice losses in the Arctic Ocean would also permit increasing numbers of commercial, tourism, and scientific vessel activity. As the Northwest Passage and Northern Sea Route remain clear of ice for longer periods of time more vessels are likely to ply the Chukchi Sea, enroute to Asian and American markets. The growing numbers of commercial vessels are unlikely to appreciably increase the likelihood of striking harbor porpoises, particularly since harbor porpoises frequently swim alongside moving vessels, for no apparent reason other than their enjoyment. The numbers of scientific, industry, and military vessels, (potentially including submarine and aircraft carrier operations), in the Chukchi and Beaufort Seas are also likely to increase along with the noise they introduce into the environment.

Effects of increasing aircraft traffic on harbor porpoises are similar to those described above for fin whales; aircraft operations should have negligible effects on harbor porpoises.

Climate change effects to the Chukchi and Beaufort Seas would most likely have a positive effect on harbor porpoises; one that is greater than all of the past, present, and foreseeable human activities combined. The effects of the Proposed Action on harbor porpoises and would not appreciably add to, subtract from, or synergistically interact with other past, present, or reasonably foreseeable future activities, or climate change, to alter the condition of harbor porpoises in the Chukchi Sea during the 21^{st} century.

Humpback Whale

Earlier and more extensive sea ice losses during the summer in the Beaufort and Chukchi Seas would affect humpback whales by opening up more habitat for them to occupy, particularly in the Northern Chukchi Sea. As the marine environment shifts towards a more pelagic system, fish production would become more favored over benthic production. Humpback whales feed on fishes and pelagic invertebrates, and larger fish stocks may be favorable for them, as would an increase in pelagic invertebrate production. When the Arctic Ocean becomes ice free, humpback whales from the North

Pacific may venture into the Atlantic Ocean to mix with humpback whales in the Atlantic. The effects of such encounters are speculative and remain so until such events occur. Climate change effects in the Chukchi and Beaufort Seas are likely to have a positive, greater, and more profound impact on humpback whale numbers, distribution, and population viability than all of the past, present, and foreseeable human activities combined.

Sea ice losses in the Arctic Ocean would also permit increasing numbers of commercial, tourism, and scientific vessel activity, as described above in the harbor porpoise section. The growing numbers of commercial vessels could increase the possibility of striking humpback whales, and would introduce more sound into the marine environment. The numbers of scientific, industry, and military vessels, (potentially including submarine and aircraft carrier operations), in the Chukchi and Beaufort Seas are also likely to increase along with the noise they introduce into the environment.

Effects of increasing aircraft traffic on humpback whales are similar to those described above for fin whales; aircraft operations should have negligible effects on humpback whales.

Climate change effects to the Chukchi and Beaufort Seas would most likely have a positive effect on humpback whales; one that is expected to be greater and more profound than all of the past, present, and foreseeable human activities combined. The effects of the Proposed Action on humpback whales and would not appreciably add to, subtract from, or synergistically interact with other past, present, or reasonably foreseeable future activities, or climate change, to alter the condition of humpback whales in the Chukchi Sea during 21st century.

Killer Whale

Earlier and more extensive sea ice losses during the summer in the Beaufort and Chukchi Seas would affect killer whales by opening up more habitat for them to occupy, particularly in the Northern Chukchi Sea. As the marine environment shifts towards a more pelagic system, fish production would become more favored over benthic production, and a concurrent increase in ribbon and spotted seals, beluga whales, and harbor porpoises, and some mysticetes whale numbers could occur. Killer whales in the Chukchi Sea feed on marine mammals, and larger fish stocks could be more favorable for them by feeding larger numbers of ribbon and spotted seals, beluga whales, harbor porpoises, and some mysticetes whales. Furthermore, when sea ice disappears, there would be no barriers or hazards preventing killer whales form occupying the Beaufort Sea and exploiting beluga and bowhead whales in their feeding concentration areas. As the Arctic Ocean becomes ice free during the summer, killer whales from the North Pacific may mix with killer whales in the Atlantic Ocean; however, the consequences of such mixing remain speculative until such an event occurs, though territorial disputes are likely. Climate change effects in the Chukchi and Beaufort Seas are likely to have a positive, greater, and more profound impact on killer whale numbers, distribution, and population viability than all of the past, present, and foreseeable human activities combined.

Sea ice losses in the Arctic Ocean would also permit increasing numbers of commercial, tourism, and scientific vessel activity, as described above in the harbor porpoise section. The growing numbers of commercial vessels are unlikely to appreciably increase the likelihood of striking killer whales, particularly since killer whales frequently swim in the vicinity of moving vessels. The numbers of scientific, industry, and military vessels, (potentially including submarine and aircraft carrier operations), in the Chukchi and Beaufort Seas are also likely to increase along with the noise they introduce into the environment.

Effects of increasing aircraft traffic on killer whales are similar to those described above for fin whales; aircraft operations should have negligible effects on killer whales.

Climate change effects to the Chukchi and Beaufort Seas would have a positive effect on killer whales; one that is greater than all of the past, present, and foreseeable human activities combined. The effects of the Proposed Action on killer whales would not appreciably add to, subtract from, or synergistically interact with other past, present, or reasonably foreseeable future activities, or climate change, to alter the condition of killer whales in the Chukchi Sea during 21st century.

Minke Whale

Earlier and more extensive sea ice losses during the summer in the Beaufort and Chukchi Seas would affect minke whales by opening new habitat for them to occupy, particularly in the Northern Chukchi Sea. As the marine environment shifts towards a more pelagic system, fish production would become more favored over benthic production. Minke whales feed on fishes and pelagic invertebrates, and larger fish stocks would favor them, as would an increase in pelagic invertebrate production. When the Arctic Ocean becomes ice free, minke whales from the North Pacific may venture into the Atlantic Ocean to mix with minke whales in the Atlantic; however, the effects from such encounters remain speculative, and remain so until such events occur. Climate change effects in the Chukchi and Beaufort Seas are likely to have a positive, greater, and more profound impact on minke whale numbers, distribution, and population viability than all of the past, present, and foreseeable human activities combined.

Sea ice losses in the Arctic Ocean would also permit increasing numbers of commercial, tourism, and scientific vessel activity. As the Northwest Passage and Northern Sea Route remain clear of ice for longer periods of time, more vessels are likely to ply the Chukchi Sea, enroute to Asian and American markets. The growing numbers of commercial vessels would increase the likelihood of striking minke whales, and would introduce more sound into the marine environment. The numbers of scientific, industry, and military vessels (potentially including submarine and aircraft carrier operations) in the Chukchi and Beaufort Seas are also likely to increase along with the noise they introduce into the environment.

Effects of increasing aircraft traffic on minke whales are similar to those described above for fin whales; aircraft operations should have negligible effects on minke whales.

Climate change effects to the Chukchi and Beaufort Seas would most likely have a positive effect on minke whales; one that is expected to be positive, greater and more profound than all of the past, present, and foreseeable human activities combined. The effects of the Proposed Action on minke whales would not appreciably add to, subtract from, or synergistically interact with other past, present, or reasonably foreseeable future activities, or climate change, to alter the condition of minke whales in the Chukchi Sea during 21st century.

Pacific Walrus

Pacific walrus populations were severely depleted during the commercial hunting period which began toward the end of commercial whale hunting in the Chukchi and Bering Seas in the 18th century. The U.S. banned commercial walrus hunting through the Congressional Walrus Act of 1941; however, Russian commercial hunting of walrus continued for some time after that. Pacific walrus populations were reduced to between 50,000 and 100,000 by the 1950s. Pacific walrus populations were further protected by the Marine Mammal Protection Act of 1972 which banned all sport hunting of walrus. An average of about 1,250 Pacific walrus are taken per year by Alaska Native subsistence hunters.

Reductions in sea ice duration and extent are causing changes in patterns of walrus habitat use and resulting in the formation of large terrestrial haulouts along the Chukchi Sea. Walrus onshore may be more vulnerable to predators and to disturbance events that cause stampedes, resulting in injuries and mortalities. Terrestrial haulouts are common on the Russian Chukotkan coastline and were historically present to a moderate extent along the Alaska coast, although no large terrestrial haulouts existed on the northern Alaska coastline (i.e., in the Chukchi and Beaufort Seas) prior to 2006 (Robards and Garlich-Miller, 2013). Recent years (e.g., 2007-2014) have seen larger terrestrial aggregations of walrus at onshore haulouts along both sides of the Bering Strait that correspond with drastic summer sea ice retreat (Garlich-Miller et al., 2011; Jay and Fischbach, 2008; Jay, Fischbach, and Kochev, 2012; Robards and Garlich-Miller, 2013). Young calves are particularly vulnerable to long periods without being able to haul out because they cannot thermoregulate as well as adults can in the cold waters of the Chukchi Sea. Once onshore, females with calves must choose between foraging in sub-optimum habitats near shore or making the long transits to offshore feeding habitats with their calves. There is also concern that increased use of terrestrial haulouts may result in localized prey depletion, as foraging areas nearest to haulouts could become over-grazed (Garlich-Miller et al., 2011; Jay, Fischbach, and Kochev, 2012). Declines in local prey populations could result in adverse impacts to individual fitness. These impacts could persist over multiple years, however, the severity of impacts and likelihood of population level effects would be dependent on many factors, including the recruitment rate of prey species and degree of walrus' reliance on specific terrestrial haulouts. The HSWUA has been identified as the primary focus of foraging walrus during the summer season when they are foraging in the Chukchi Sea (Jay, Fischbach, and Kochnev, 2012). Walrus onshore are also more sensitive to disturbance events, which may result in trampling injuries and mortalities. Young calves are particularly vulnerable during stampedes, and these events could lead to population level effects (Fischbach et al., 2009; Udevitz et al., 2013).

Changes in ocean acidity and temperature as well as sea ice cover may lead to impacts on the availability of benthic invertebrates as prey items as well (Section 5.2.3).

Increases in shipping and icebreaker traffic, particularly if it transits through the HSWUA or near shore-based terrestrial haulouts, may increase disturbance events and result in mortalities from ship strikes or prop injuries. Calves may be separated from their mothers during disturbance events onshore or on ice. Calves remain dependent upon their mothers for two years or more, and once separated from their mothers, calves would not survive. Low flying aircraft may also cause disturbance events and stampedes, particularly at shore-based haulouts.

Increases in the potential for disturbance and displacement from important foraging habitat due to activities resulting from the Proposed Action would have an additive effect. Walrus are increasingly coming into contact with vessels while in the Chukchi Sea as research, shipping, and industry activities all increase. This increased potential for human disturbance is occurring as sea ice habitat is decreasing and food resources may be declining due to climate change. Industry activities taking place during this time period may require additional mitigation measures or may not be authorized under the Chukchi Sea ITRs, if large concentrations of walrus are within the HSWUA at the time certain Scenario activities are proposed. Currently, there are approximately 35 leases within the HSWUA, and an additional four that are partially within the HSWUA.

Bearded Seal

Increasing sea ice losses during the summer in the Arctic Ocean are expected to have detrimental effects on bearded seals. As sea ice melts, basking and resting habitat would be depleted, and a decoupling of the sea ice – benthic nutrient flow may occur that would decrease benthic production while favoring pelagic production. Bearded seals are predominately benthic feeders, and decreases in benthic food stocks could affect the Beringian DPS of bearded seals. While most bearded seals whelp in the Bering Sea, some remain in the Beaufort and Chukchi Seas throughout the year. Whelping conditions for resident bearded seals could temporarily improve with larger lead and polynya systems offering greater access to water and an increase in the sea ice edge effect in those areas. In the Bering Sea where most bearded seals whelp, sea ice would continue to form, though likely to areas farther north than presently occurs, and those bearded seals should continue to successfully reproduce. During the open water season, bearded seals spend most of their time in the water feeding, and will haul out onshore in some areas where haulout locations meet their needs. Considering the behavior of bearded seals in the Sea of Okhotsk, the use of islands and onshore haulouts by bearded seals is likely to increase into the future as sea ice disappears, providing such areas remain undisturbed.

Bearded seals feed on benthos, and larger fish stocks may be less favorable for them; however, they frequently feed on fish when the opportunity arises, and some decreases of benthic food resources may not produce severe impacts to this species. If there is an increase in other piscivorous species (i.e. spotted and ribbon seals) or whales (i.e. fin, humpback and minke whales) or an influx of immigrant species (i.e. harbor, harp, hooded or gray seals, or Steller sea lions, etc.) then there could be a rise in interspecific competition that may be detrimental to bearded seals. In the long-term, ocean acidification could have serious repercussions among benthic and pelagic food stocks, resulting in a net loss of the food base for bearded seals. Such effects are unlikely to occur in the near future; however, with the expected losses among marine micro-biota the entire marine food web would undergo some level of change from its current state, which could be very harmful to bearded seals. For these reasons, climate change effects in the Chukchi and Beaufort Seas are likely to have a greater and more profound impact on bearded seal numbers, distribution, and population viability than all of the past, present, and foreseeable human activities combined.

Sea ice losses during the summer in the Arctic Ocean would also permit increasing numbers of commercial, tourism, and scientific vessel activity. As the Northwest Passage and Northern Sea Route remain clear of ice for longer periods of time more vessels are likely to ply the Chukchi Sea, enroute to Asian and American markets. The growing numbers of commercial vessels would increase the likelihood of striking bearded seals, and would introduce more sound into the marine environment. In recent years, some seals have been wounded or killed by ducted propeller systems on oceangoing vessels in the North Atlantic, and the potential exists for similar accidents to occur in the Chukchi and Beaufort Sea. However, seals are very agile in the water and easily avoid vessel strikes under normal conditions. The numbers of scientific and industry survey vessels in the Chukchi and Beaufort Seas are also likely to increase, along with the noise they introduce into the environment. Because an increase in military and USCG activity in the Chukchi and Beaufort Seas is anticipated, U.S. Navy and USCG vessel presence in the Chukchi and Beaufort Seas is also likely to increase.

Commercial, military, and scientific aircraft operations are expected to increase into the foreseeable future. Greater use of military jets and helicopters would introduce more noise, though most military aircraft usually maintain an altitude of several thousand feet above the water or land surface, which minimizes the disturbance to the marine environment. Scientific surveys using aircraft such as the ASAMM, BOWFEST, BWASP, etc. fly at altitudes sufficient to negate most transfer of sound into the water. Aircraft have little effect on bearded seals when they are in the water; however, hauled out bearded seals may display flight reactions if approached too closely by low-flying aircraft. Most flight reactions consist of quickly slipping into the water. Throughout the 21st century, aircraft operations should have negligible effects on bearded seals.

Climate change effects to the Chukchi and Beaufort Seas would most likely have mixed effects on bearded seals; one that is expected to be greater than all of the past, present, and foreseeable human activities combined. In the near term, bearded seals will enjoy larger lead systems and polynya systems, which may support larger numbers of bearded seals. Likewise, the increased productivity in the Arctic Ocean from increased terrestrial inputs and longer ice-free seasons could better support bearded seals, at least into the near future. In the long-term, climate change effects are expected to eliminate summer sea ice, and possibly wreak havoc on many species of marine fauna, including some species that are crucial to the existing food web. The effects of the Proposed Action on bearded seals would not appreciably add to, subtract from, or synergistically interact with other past, present, or reasonably foreseeable future activities, or climate change, to alter the condition of bearded seals in the Chukchi Sea during 21st century.

Ribbon Seal

Sea ice losses during the summer in the Arctic Ocean are expected to have positive effects on ribbon seals. As the Arctic Ocean becomes ice free and waters warm, pelagic production would increase, favoring ribbon seals. Sea ice losses would not affect ribbon seal haulouts or whelping, since neither activity normally occurs in the Chukchi Sea. Except for whelping and molting, ribbon seals remain in the water throughout the year, meaning large areas of the Chukchi and Beaufort Seas would open up for the species in an ice-free future. Because they are piscivorous, increases in fish stocks could positively affect ribbon seals by providing more food resources. Climate change effects in the Chukchi and Beaufort Seas should have a positive, greater, and more profound impact on bearded seal numbers, distribution, and population viability than all of the past, present, and foreseeable human activities combined.

Sea ice losses in the Arctic Ocean would also permit increasing numbers of commercial, tourism, and scientific vessel activity, as described above in the section on bearded seals. The growing numbers of commercial vessels would increase the likelihood of striking ribbon seals, and would introduce more sound into the marine environment. In recent years, some seals have been wounded or killed by ducted propeller systems on oceangoing vessels in the North Atlantic, and the potential exists for similar accidents to occur in the Chukchi and Beaufort Sea. However, seals are very agile in the water and easily avoid vessel strikes under normal conditions. The numbers of scientific, industry, and military vessels (potentially including submarine and aircraft carrier operations) in the Chukchi and Beaufort Seas are also likely to increase along with the noise they introduce into the environment.

Effects of increasing aircraft traffic on ribbon seals are similar to those described above for bearded seals; aircraft operations should have negligible effects on ribbon seals.

Climate change effects to the Chukchi and Beaufort Seas would have a positive effect on ribbon seals; one that is expected to be greater than all of the past, present, and foreseeable human activities combined. The effects of the Proposed Action on ribbon seals would not appreciably add to, subtract from, or synergistically interact with other past, present, or reasonably foreseeable future activities, or climate change, to alter the condition of ribbon seals in the Chukchi Sea during 21st century.

Ringed Seal

Sea ice losses during the summer in the Arctic Ocean are expected to have detrimental effects on ringed seals. As sea ice melts, ice-based whelping, basking, and resting habitat would be depleted, and could eventually disappear. Though sea ice is necessary for birthing lairs and whelping, in other parts of the species range terrestrial haulouts are used if sea ice is absent. Most ringed seals whelp in the Bering Sea; however, many remain in the Beaufort and Chukchi Seas throughout the year. Whelping conditions for resident ringed seals are expected to degrade with increasing rain-on-snow events compromising the integrity of subnivean ringed seal birthing dens. In the Bering Sea where some ringed seals whelp, sea ice would continue forming in the fall, though the maximum ice extent may end farther north than it does now. During the open water season, ringed seals spend most of their time in the water feeding, and have been known to haul out onshore in some areas where haulout locations meet their needs, such as portions of Hudson Bay, Canada. Considering the behavior of ringed seals in the Sea of Okhotsk, the Baltic Sea, and inland lakes of Scandinavia, the use of islands and onshore haulouts by ringed seals may increase into the future as sea ice disappears, providing such areas remain undisturbed.

Ringed seals feed on fishes, and large stocks of fishes would favor them, meaning the expected increases in pelagic fish and invertebrate production may be a positive effect of climate change on ringed seals. An increase in the numbers of other piscivorous species (i.e. spotted and ribbon seals) or whales (i.e. fin, humpback, and minke whales), and/or an influx of immigrant species (i.e. harbor, harp, hooded, or gray seals, or Steller sea lions, etc.) could lead to a rise in competition that may be detrimental to ringed seals. Climate change effects in the Chukchi and Beaufort Seas are likely to have greater impact on ringed seal numbers, distribution, and population viability than all of the past, present, and foreseeable human activities combined.

Sea ice losses during the summer in the Arctic Ocean would also permit increasing numbers of commercial, tourism, and scientific vessel activity. As the Northwest Passage and Northern Sea Route remain clear of ice for longer periods of time more vessels are likely to ply the Chukchi Sea, enroute to Asian and American markets. The growing numbers of commercial vessels would increase the likelihood of striking ringed seals, and would introduce more sound into the marine environment. In recent years, some seals have been wounded or killed by ducted propeller systems on oceangoing vessels in the North Atlantic, and the potential exists for similar accidents to occur in the Chukchi and Beaufort Sea. However, seals are very agile in the water and easily avoid vessel strikes under normal conditions. The numbers of scientific and industry survey vessels in the Chukchi and Beaufort Seas are also likely to increase along with the noise they introduce into the environment. Because an increase in military and USCG activity in the Chukchi and Beaufort Seas is anticipated, U.S. Navy and USCG vessel presence in the Chukchi and Beaufort Seas is also likely to increase.

Effects of increasing aircraft traffic on ringed seals are similar to those described above for bearded seals; aircraft operations should have negligible effects on ringed seals.

Climate change effects to the Chukchi and Beaufort Seas would most likely have some positive, and some negative effects on ringed seals; greater and more profound than all of the past, present, and foreseeable human activities combined. The effects of the Proposed Action on ringed seals would not appreciably add to, subtract from, or synergistically interact with other past, present, or reasonably foreseeable future activities, or climate change, to alter the condition of ringed seals in the Chukchi Sea during 21st century.

Spotted Seal

Sea ice losses in the Arctic Ocean should not have detrimental effects on spotted seals, which readily haul out on islands, mudbars, and other coastal areas. Spotted seals are predominately pelagic feeders, feeding on fishes and invertebrates in the water column. In the Bering Sea, where most spotted seals whelp, sea ice would continue to form, though likely to areas farther north than presently occurs, and those spotted seals should continue to successfully reproduce and whelping conditions should not change significantly. During the open water season, spotted seals spend most of their time in the water feeding, and considering their behavior in the Sea of Okhotsk, Bering Sea, and Yellow Sea, the use of islands and onshore haulouts by spotted seals is likely to increase into the future as sea ice disappears, providing such areas remain undisturbed.

Spotted seals feed on fish, so large stocks of fish would favor them. Consequently, the expected increases in pelagic fish and invertebrate production should be a positive effect of climate change on spotted seals. If numerical increases of other piscivorous seals (i.e. spotted and ribbon seals) or whales (i.e. fin, humpback, and minke whales) and/or an influx of immigrant species (i.e. harbor, harp, hooded, or gray seals, or Steller sea lions, etc.) occurs, a rise in interspecific competition might also occur which could be detrimental to spotted seals. Climate change effects in the Chukchi and Beaufort Seas are likely to have a positive effect on spotted seals that is greater, and more profound, with respect to impacts spotted seal numbers, distribution, and population viability, than all of the past, present, and foreseeable human activities combined.

Sea ice losses in the Arctic Ocean would also permit increasing numbers of commercial, tourism, and scientific vessel activity, as described above in the section on bearded seals. The growing numbers of commercial vessels would increase the possibility of striking spotted seals, and would introduce more sound into the marine environment. In recent years, some seals have been wounded or killed by ducted propeller systems on oceangoing vessels in the North Atlantic, and the potential exists for similar accidents to occur in the Chukchi and Beaufort Sea. However, seals are very agile in the water and easily avoid vessel strikes under normal conditions. The numbers of scientific, industry, and military vessels (potentially including submarine and aircraft carrier operations) in the Chukchi and Beaufort Seas are also likely to increase along with the noise they introduce into the environment.

Effects of increasing aircraft traffic on spotted seals are similar to those described above for bearded seals; aircraft operations should have negligible effects on spotted seals.

Climate change effects to the Chukchi and Beaufort Seas would have a positive effect on spotted seals; one that is expected to be greater than all of the past, present, and foreseeable human activities combined. The effects of the Proposed Action on spotted seals would not appreciably add to, subtract from, or synergistically interact with other past, present, or reasonably foreseeable future activities, or climate change, to alter the condition of spotted seals in the Chukchi Sea during 21st century.

Polar Bear

Prior to the passing of the Marine Mammal Protection Act, sport hunters took large numbers of polar bears in Alaska, with population level impacts. After the passing of the Act in 1972, polar bear numbers increased. Current levels of anthropogenic activity related to the oil and gas industry in Alaska result in occasional disturbance of individual bears, generally due to vessel, aircraft or ground traffic or due to hazing bears away from human activity or habitation. Polar bears are also hazed away from villages in Alaska and Chukotka, and some bears are taken in defense of life or through subsistence hunting. In 2013, for example, a total of 52 bears were taken by subsistence hunters in Alaska from the Southern Beaufort Stock (SBS) and the Beaufort-Chukchi Stock (BCS) polar bear populations (USFWS, 2014a).

Commercial shipping, tourism cruises, and research cruises are increasing in the Arctic and are projected to continue to increase, including icebreakers used for all three purposes. As sea ice retreat makes the Northwest Passage and the Northern Sea Routes more viable for tourism and cargo vessels, more vessels are expected to access these routes throughout the longer open water season. The increase in vessel traffic increases the potential risk of accidents and spills. While individual icebreakers are unlikely to alter the sea ice habitat during the freeze-up period or in winter, increased icebreaker traffic during the spring melt season, combined with reduced sea ice, may result in smaller floes after icebreaking that melt more quickly, reducing the availability of sea ice for marine mammals to rest on. Where icebreakers repeatedly traverse a specific route, for example, to keep it open for access by other vessels, changes in the ice formation along the edges of the artificial lead may result in the lead remaining open longer (Mahoney et al., 2012).

Arctic sea ice extent has shown a decreasing trend for all months from 1979 to the present. These trends are expected to continue (Stroeve et al., 2012). The decrease in September sea ice extent combined with other factors leads to thinner first year ice cover in spring. As the warming trend continues, sea ice cover in the arctic may be limited to first year ice with little or no multi-year ice extending into the Chukchi Sea (Zhang and Walsh, 2006). As the open water period increases, many polar bears would spend more of the year in sub-optimum foraging habitat. Bears would either come ashore or they remain with the sea ice as it moves northward off the shelf and over waters that are not inhabited by their prey species. Onshore, bears may fast or rely on marine mammal carcasses for food, which may bring them increasingly into conflict with humans near villages where food sources are available. Human-bear conflicts in villages in the Chukotka region and on the North Slope of Alaska have led to the formation of ‘bear patrols’ in an effort to haze bears away from villages before it becomes necessary to shoot them in order to protect human life. Bears on sea ice that has retreated off of the Continental Shelf may fast for long periods. They may also be forced to attempt to swim long distances to shore or to other available sea ice as the melting ice breaks up in summer (Pagano et al., 2012). The Southern Beaufort Sea population of polar bears has decreased in number and in size in recent decades as sea ice availability and access to prey decline (Rode, Amstrup and Regehr, 2010; Bromaghin et al., 2014). The Bering/Chukchi Seas population of polar bears has not shown a decline in body condition, size or recruitment to date (Rode et al., 2014). These differences may be attributed to differences in prey and sea ice availability between the Southern Beaufort and Chukchi Seas. However, as sea ice continues to decline (and especially if populations of ice-dependent pinnipeds, the primary prey of polar bears, decline as a result of reduced availability of sea ice habitat, as anticipated), polar bear populations in the Chukchi Sea would also decline (Amstrup, Marcot, and Douglas, 2007).

Currently, the greatest challenge for polar bear populations world-wide are warming temperatures and sea ice loss due to climate change. CBS bears have not yet been impacted by sea ice loss to the extent that other populations, such as the SBS population have been. It has been predicted that climate change with the resulting warming temperatures and loss of sea ice would lead to polar bears being extirpated from the divergent ice areas within 75 years. The southern Beaufort and Chukchi Seas are part of the divergent ecoregion (Amstrup, Marcot, and Douglas, 2007). To date, impacts on polar bear populations from the oil and gas industry have been limited primarily to disturbance in the Beaufort Sea and adjacent shoreline. Increases in shipping, research, village bear viewing tourism, ship-based tourism, and icebreaker activities may all increase human-bear interactions, resulting in increases in disturbance and potential injuries to bears. These impacts are more pronounced on the Beaufort shoreline rather than the Alaskan Chukchi Sea shoreline. Continued sea ice loss may result in CBS bears onshore spending more time searching for food near villages in Chukotka which may increase the numbers of bears taken in defense of human life. The Proposed Action would have an additive effect to the other sources of human-bear interactions: primarily the existing industry foot print, bear viewing tourism, and human-bear interactions in and near villages. Cumulatively, the Proposed Action would have a moderate to major level of impact on polar bears that could rise to major in the event of a spill.

5.2.6.4. Summary/Conclusion

Beluga Whale

Though vessel traffic and/or a large spill event could have moderate effects on belugas, such effects would be short-term with no long-term lingering effects on the species. In comparison the effects of climate change would be negligible to minor at any given time, yet have major or even catastrophic long-term effects on this species. The greatest human activities and effectors on beluga whales would be anthropogenic climate change, followed by subsistence hunting, and commercial vessel traffic. Other activities are either too limited in their effects to produce noticeable impacts on belugas, or lack overlap with beluga whale life cycles and requirements.

While the contribution of the Proposed Action to effects on beluga whales would be negligible, the anticipated cumulative effects of past, present and reasonably foreseeable future activities would represent a major level of effects due to the effects of climate change.

Bowhead Whale

Though vessel traffic and/or a large spill event could have moderate effects on bowhead whales, such effects would be short-term with no long-term lingering effects on the species. In comparison, the effects of climate change would be negligible to minor at any given time, yet have major or even catastrophic long-term effects on this species. The greatest human activities and effectors on bowhead whales would be anthropogenic climate change, followed by subsistence hunting, and commercial vessel traffic. Other activities are either too limited in their effects to produce noticeable impacts on bowheads, or lack overlap with bowhead whale life cycles and requirements While the contribution of the Proposed Action to effects on bowhead whales would be negligible, the anticipated cumulative effects of past, present and reasonably foreseeable future activities would represent a major level of effects due to the effects of climate change.

Fin Whale

Vessel traffic and/or a large spill event would have negligible short-term effects on fin whales, considering their scarcity. In comparison climate change on this species would have negligible effects on this species at any given time, yet have major long-term positive effects on this species. The effects of the Proposed Action would mostly be negligible for fin whales since fin whales are scarce in the Leased Area. The greatest human activities and effectors on fin whales would be anthropogenic climate change, followed by subsistence hunting, and commercial vessel traffic. Other activities are either too limited in their effects to produce noticeable impacts on fin whales, or lack overlap with fin whale life cycles and requirements. While the contribution of the Proposed Action to effects on fin whales would be negligible, the anticipated cumulative effects of past, present and reasonably foreseeable future activities would represent a major level of effects due to the effects of climate change.

Gray Whale

Though vessel traffic and/or a large spill event could have moderate effects on gray whales, such effects would be short-term with no long-term lingering effects on the species. In comparison the effects of climate change would be negligible to minor at any given time, yet have major long-term effects on this species. The greatest human activities and effectors on gray whales would be anthropogenic climate change, followed by subsistence hunting, and commercial vessel traffic. Other activities are too limited in their effects to produce noticeable impacts on grays, or lack overlap with gray whale life cycles and requirements. While the contribution of the Proposed Action to effects on gray whales would be negligible, the anticipated cumulative effects of past, present and reasonably foreseeable future activities would represent a major level of effects due to the effects of climate change.

Harbor Porpoise

Though vessel traffic and/or a large spill event could have moderate effects on harbor porpoises, such effects would be short-term with no long-term lingering effects on the species. In comparison the effects of climate change would be negligible to minor at any given time, yet have major long-term positive effects on this species. The greatest effector on harbor porpoises would be climate change, which would open up new habitat to harbor porpoises in the Arctic Ocean. Other activities are either too limited in their effects to produce noticeable impacts on harbor porpoises, or lack overlap with harbor porpoise life cycles and requirements. While the contribution of the Proposed Action to effects on harbor porpoises would be negligible, the anticipated cumulative effects of past, present and reasonably foreseeable future activities would represent a major level of effects due to the effects of climate change.

Humpback Whale

Though vessel traffic and/or a large spill event could have moderate effects on humpback whales, such effects would be short-term with no long-term lingering effects on the species. In comparison the effects of climate change would be negligible to minor at any given time, yet have major long-term positive effects on this species. The greatest human activities and effectors on humpback whales would be anthropogenic climate change, followed by commercial vessel traffic. Other activities are either too limited in their effects to produce noticeable impacts on humpbacks, or lack overlap with humpback whale life cycles and requirements. While the contribution of the Proposed Action to effects on humpback whales would be negligible, the anticipated cumulative effects of past, present and reasonably foreseeable future activities would represent a major level of effects due to the effects of climate change.

Killer Whale

Though vessel traffic and/or a large spill event could have moderate effects on killer whales, such effects would be short-term with no long-term lingering effects on the species. In comparison, the effects of climate change would be negligible to minor at any given time, yet have major long-term positive effects on this species. The greatest human activities and effectors on killer whales would be climate change which would open new habitat to killer whales. Other activities are either too limited in their effects to produce noticeable impacts on killers, or lack overlap with killer whale life cycles and requirements. While the contribution of the Proposed Action to effects on killer whales would be negligible, the anticipated cumulative effects of past, present and reasonable foreseeable future activities would represent a major level of effects due to the effects of climate change.

Minke Whale

Though vessel traffic and/or a large spill event could have moderate effects on minke whales, such effects would be short-term with no long-term lingering effects on the species. In comparison the effects of climate change would be negligible to minor at any given time, yet have major long-term positive effects on this species. The greatest human activities and effectors on minke whales would be anthropogenic climate change which would open new habitat to minkes, followed by commercial vessel traffic. Other activities are either too limited in their effects to produce noticeable impacts on minkes, or lack overlap with minke whale life cycles and requirements that include sea ice loss, changes in the prey base, ocean acidification, etc. While the contribution of the Proposed Action to effects on minke whales would be negligible, the anticipated cumulative effects of past, present and reasonable foreseeable future activities would represent a major level of positive effects due to the effects of climate change.

Bearded Seal

Though vessel traffic and/or a large spill event could have moderate effects on bearded seals such effects would be short-term with no long-term lingering effects on the species. In comparison the effects of climate change would be negligible to minor at any given time, yet have major or even catastrophic long-term effects on this species. The greatest human activities and effectors on bearded seals would be anthropogenic climate change, and subsistence hunting. Other activities are either too limited in their effects to produce noticeable impacts on bearded seals, or lack overlap with bearded seal life cycles and requirements. While the contribution of the Proposed Action to effects on bearded seals would be negligible, the anticipated cumulative effects of past, present and reasonable foreseeable future activities would represent a major level of effects due to the effects of climate change.

Pacific Walrus

The Proposed Action’s contribution to cumulative impacts may rise to moderate but would depend in part on the level of mitigation that is incorporated into the activities, and in part on the precise location of exploration and production activities. Leases from Lease Sale 193 in the Chukchi Sea are within the walrus’ summer foraging area, and 39 leases are within the Hannah Shoal Walrus Use Area (HSWUA). For the 2013-2018 Incidental Take Regulations, the USFWS has incorporated special seasonal closures for the HSWUA to minimize impacts to foraging walrus. Assuming the next five year Incidental Take Regulations are similar as to the HSWUA, and production occurs at the levels depicted in the Scenario, the levels of benthic habitat lost and the levels of human activity in and adjacent to the HSWUA in combination with other ongoing stressors to walrus would result in moderate cumulative impacts to walrus.

Ribbon Seal

The greatest human activities and effectors on ribbon seals would be climate change and subsistence hunting. Other activities are either too limited in their effects to produce noticeable impacts on ribbon seals, or lack overlap with ribbon seal life cycles and requirements. Cumulatively, the overall effects of the Proposed Action, combined with past, present, and reasonably foreseeable activities would not change or add appreciably to the overall effects on ongoing climate change.

Ringed Seal

Though vessel traffic and/or a large spill event could have moderate effects on ringed seals, such effects would be short-term with no long-term lingering effects on the species. In comparison, the effects of climate change would be negligible to minor at any given time, yet have minor to major long-term negative effects on this species. The greatest human activities and effectors on ringed seals would be climate change and subsistence hunting. Other activities are too limited in their effects to produce noticeable impacts on ringed seals, or lack overlap with ringed seal life cycles and requirements. While the contribution of the Proposed Action to effects on ringed seals would be negligible, the anticipated cumulative effects of past, present and reasonable foreseeable future activities would represent a major level of effects due to the effects of climate change.

Spotted Seal

Though vessel traffic and/or a large spill event could have moderate effects on spotted seals, such effects would be short-term with no long-term lingering effects on the species. In comparison the effects of climate change would be negligible to minor at any given time, yet have minor to major long-term adverse and positive effects on this species. The greatest human activities and effectors on spotted seals would be climate change, and subsistence hunting. Other activities are either too limited in their effects to produce noticeable impacts on spotted seals, or lack overlap with spotted seal life cycles and requirements. While the contribution of the Proposed Action to effects on spotted seals would be negligible, the anticipated cumulative effects of past, present and reasonably foreseeable future activities would represent a major level of positive effects due to the effects of climate change.

Polar Bear

The Proposed Action would result in some disturbance of bears in areas where industry activities take place onshore or on ice. This would occur primarily in the development and production phases. The overall contribution of the Proposed Action to cumulative impacts on polar bears is expected to be negligible, but could rise to major in the event of one or more large spills, depending on the location and timing of the spill.

5.2.7. Terrestrial Mammals

5.2.7.1. Summary of Direct and Indirect Effects

The effects of the Proposed Action were analyzed in Chapter 4 of this document and are summarized below in Table 5-19.

Table 5-19. Effects of the Proposed Action on Terrestrial Mammals.

Terrestrial Mammal Species	Effects from Chapter 4
Caribou	Minor
Muskox	Negligible
Grizzly Bear	Negligible
Furbearers	Negligible

The Proposed Action would include activities that could impact terrestrial mammals. Effects from the physical presence and noise from aircraft/onshore facilities, vehicle and equipment operations, pipeline construction, habitat alteration and spills are highly localized and habitat alterations would persist over years or decades. The greatest effects to terrestrial mammals, particularly caribou would arise from aircraft, vehicle, and equipment operations during facility and pipeline construction that could induce injurious escape reactions among caribou, especially caribou herds and individuals with young.

5.2.7.2. Discussion of Other Relevant Actions

Oil and Gas Activities

Since the early 1900s, oil and gas exploration have occurred on the North Slope, with development and production near Prudhoe Bay commencing in the early 1970s and continuing to the present day and beyond. Of particular relevance here was the construction of the TAPS in 1977; this pipeline continues to convey produced oil southward from Prudhoe Bay-area developments to Valdez along the southern Alaskan coast. More recently, exploration has occurred on the Beaufort Sea OCS and Chukchi Sea and in onshore areas within the NPR-A. In the 1980s, exploration activities were conducted in the Beaufort Sea, and in 1989 and the early 1990s, an oil and gas operator conducted exploration activities in the Leased Area, with no residual effects on terrestrial mammals. Presently, there are plans to bring the Liberty project into production in the Beaufort Sea, and the Greater Mooses Tooth project in the NPR-A. Concurrent with recent oil and gas exploration and development activities in the U.S., both Canada and Russia are engaged in offshore exploration and development projects in the eastern Beaufort and Siberian Sea respectively.

In addition to exploration and field development, the State of Alaska and industry are investigating the feasibility of constructing a natural gas pipeline from Prudhoe Bay to south-central Alaska with possible spurs to fuel communities near the pipeline route. Creation of pipelines could have minor to moderate effects on terrestrial mammal species, and effects would be greater if animal migration corridors and routes become fragmented by pipelines.

Future oil and gas activities in the Chukchi Sea would likely concentrate in the vicinity of the Leased Area, while some smaller fields within the NPR-A could be developed. Likewise, Canada and Russia are expected to develop their offshore oil and gas resources to the fullest extent possible. In preparation for future oil and gas activities, Russia has been actively upgrading and creating support infrastructure along their Arctic coastline. Gearon et al. (2014) modelled the spread of spills originating in the Eastern Beaufort Sea, and found oil from a theoretical 5.4 million bbl well blowout could contact some Beaufort and Chukchi Sea nearshore areas. Such events would be highly unlikely considering the issues of geology, reservoir sizes, water depths, and pressures involved; nor should spills originating in the Siberian Sea affect terrestrial mammals in the Leased Areas; however, if spills in Canada or Russia were large enough they might induce marine mammals in those areas to disperse to other areas that could include the Chukchi Sea Lease Areas.

Economic Development

The effects of economic development could include increased financial resources for subsistence hunters, which could result in more fuel and more or better equipment for subsistence activities and lead to increased levels of subsistence hunting. Consequences of increased levels of subsistence activity would include larger marine and terrestrial mammal harvests, and increased noise from greater small vessel use in the Chukchi and Beaufort Seas.

In the long term, harvests of some terrestrial mammal species should decline in tandem with the effects climate change has on populations of Arctic fox, caribou, and muskox; however, harvests of other species such as moose, grizzly bears, and some furbearing species could increase if greater proportions of their populations shift north in response to more suitable climatic conditions and increased biological productivity.

Recreation and Tourism

The opening of Arctic waterways connecting the Beaufort Sea with the western Atlantic Ocean and the Chukchi Sea with eastern Atlantic Ocean has allowed a tourism industry to develop in recent years and levels are expected to increase in the future. Such tours involve cruise ships which produce noise and discharges, as well as onshore activities including sport hunting and fishing, wildlife viewing, photography, and adventure activities. Sport hunting and fishing could produce moderate effects on some wildlife and fish populations since individuals are harvested, but population level effects are not anticipated. In comparison, activities such as wildlife viewing, and adventuring do not typically impact wildlife population. The overall effects of recreation and tourism on marine mammals are expected to be moderate due to mortalities associated with recreational hunting and fishing.

Aircraft Traffic

Aircraft use over the Chukchi Sea and Leased Area are typically performed by oil and gas exploration companies, and by government entities who conduct surveys such as ASSAM, BOWFEST, etc. Assuming exploration, development, production, and decommissioning occur, air-traffic levels within the Leased Area and between the Anchor Field, Satellite Field, and the coast would increase substantially and likely occur year-round, rather than seasonally. Aircraft traffic to and between communities, camps and infrastructure developments could also occur as pipeline construction, pumping stations, etc. are developed.

Air traffic may have minor to moderate impacts on terrestrial mammals if aircraft altitudes drop below 1,500 feet.

Subsistence

Thousands of caribou are harvested annually in subsistence hunts, along with many other species of mammals including moose, muskox, grizzly bear, Dall sheep, marmots, hares, and various furbearing animals.

Numbers of animals harvested varies by community and hunting areas typically radiate out from each community for many miles. Consequently, each community represents a particular subsistence area and no two are exactly alike. The numbers of animals occurring in such areas are likely to be more skittish than those animals occurring elsewhere, and disturbance events could elicit more overt reactions from terrestrial mammals in such areas.

Scientific Research

The effects of existing research-oriented aircraft traffic and vessel traffic on terrestrial mammals And generally occur during the open water season (July-October). Another type of survey activity is on-ice research that usually occurs in winter and early spring, but may also occur on pack ice during the open water season. These activities are limited in the amount of disturbance they produce, due to the small footprint of their operations, the limited amount of potential disturbance created, and the limited duration and magnitude of fieldwork.

The effects to terrestrial mammals from scientific research would be minor to moderate, with moderate effects associated with the collection of museum specimens, kills-trapping, and other invasive study plan designs leading to moderate levels of effect.

Mining

The Red Dog mine is located in the western Brooks Range near the Chukchi Sea coast, and is the world’s largest zinc mine. Other mineral mines are proposed for the western Brooks Range and a potential coal mine may open in the near future near the Chukchi Sea coast. Development of the proposed mines remains contingent upon creating a spur road from the Dalton Highway to the Ambler Mining District and from there to the Red Dog mine and potentially the Seward Peninsula.

Barring unforeseeable accidents, it is unlikely mining itself would have any identifiable effects on terrestrial mammals; however, road creation and the vehicular, air, and vessel traffic associated with such mines would produce negligible to moderate levels of effects due to impacts on individual animals.

Military

Barring cold-war submarine operations under sea ice, there has been very little military activity in the Chukchi and Beaufort Seas. Sea ice extent and distribution has always been an obstacle to U.S. Navy (USN) and U.S. Coast Guard (USCG) activity in these areas, and would continue to do so to a lesser degree in upcoming decades. The USCG icebreakers HEALY and POLAR STAR are the only U.S.-flagged vessels capable of breaking ice in the Chukchi Sea (Riddle, K.W., 2014).

The burgeoning interest in the Arctic has the U.S. Navy exploring available options for suitable deepwater ports and airstrips with access to Arctic waters in Alaska. No final decisions have been finalized or publicized; however, the recent Russian military build-up along their Russian Arctic coast may precipitate similar actions by the USN (Climate Change Task Force, 2014; Titley and St. John, 2010).

Climate Change

Climate change in the Arctic is the driving factor behind increasing vessel traffic, air traffic, military activity, and economic development. It is also expected to have the greatest effects on terrestrial mammals in the Arctic. The direct and indirect effects of climate change on terrestrial mammals include primary and secondary changes to ecological processes that mammalian species depend on for life. Some such changes could be beneficial to certain species and detrimental to others, depending on what life processes are affected for a species and the manner in which those effects occur.

Increasing warmth could lead to increased sea ice losses, increased glacial ice melt, earlier and faster snowmelt, extended growing seasons, and shortened winters. Likewise, the summer and winter air and water temperatures would increase, as may the amount of precipitation. Collectively, these effects of climate change could have major impacts in the marine, coastal, and terrestrial environment of Alaska, which could affect every living organism to one degree or another. Under future conditions, the soil would become more likely to dry out in some areas and become more hydrated in others, slough off of slopes, erode, and release soil constituents such as CO_2 (Natali et al., 2014) and methane into the atmosphere. Recently, several large holes have appeared in northern Siberia where the permafrost has melted along with methane hydrates in the soil, with the largest of these holes measures 30 m (98 ft) wide by about 70 m deep (230 ft) (Moskvitch, 2014).

Melting permafrost can also create melt ponds and lakes on tundra in low lying areas. Such catchments of soil moisture are unlikely to directly flow into streams and may be ephemeral. Rivers and streams along the ACP would also experience impacts from changes to the climate with earlier episodes of spring flooding (Nghiem et al., 2014; Beltaos, 2013; Queenie et al., 2012) followed by decreases in groundwater inputs derived from melting snow, ice, and permafrost (Qiu, 2012). Spring and summer flooding of river systems can lead to large influxes of warmer freshwater into the Arctic marine environment. If such events occur in a rapid surge as opposed to a steady inflow, extensive areas of sea ice can rapidly melt (Nghiem et al., 2014).

Sea ice losses in the Arctic Ocean may lead to larger storms, resulting in larger waves that would weather away coastlines and islands more rapidly (Vavrus, 2013), and such events would permit larger and more frequent storm surges to reach farther inland from the coast. Storms and storm surges, along with warming air, would facilitate the thawing of permafrost in Arctic soils such that the annual depth of thawed soils would increase (Kittel, Baker, Higgins, and Haney, 2011; Vavrus, 2013), leading to the release of soil organic matter into watersheds. Nearshore areas of the Beaufort and Chukchi Seas would receive larger surges of organic influxes from eroding coastlines, streambanks, and from the thawing permafrost that would add to the organic constituents to the marine food web.

Ocean acidification would continue to occur as a result of climate change, and would affect the levels of calcium carbonate available to invertebrates for shell development. Under such conditions benthic creatures such as bivalves and polychaete worms would have difficulty creating and maintaining shells while species such as jellies, sea urchins, etc. might flourish. At the microbial level, blue-green algae could have trouble creating the calcium carbonate matrices needed to permit them to remain near the surface of the ocean, and such a situation could have severe repercussions throughout the food web in the oceans. Anadromous fishes spawn in freshwater streams, often dying afterwards. In doing so, they provide an influx of nutrients from the marine environment to the terrestrial environment. Those nutrients positively affect vegetation growth and production in riparian areas, which provides more nutritious food to caribou, muskoxen, and other herbivores, as well as bears. Grizzly bears, and some furbearers such as wolves and wolverines, feed on salmon and other fishes if provided the opportunity, and in doing so, receive high quality nutrition directly from the ocean. Likewise, the herbivores feeding on riparian vegetation are often eaten by predators such as grizzly bears and furbearing mammals such as wolves, foxes, wolverines, etc.

Both summer and winter temperatures are expected to increase across the NPR-A in northwestern Alaska through this century, with the greatest changes occurring in winter. Average winter temperatures are likely to increase by as much as 18°F (10°C) by the 2090s, rising well above 0°F (18°C), as compared to historical averages of almost ten below (-23°C), while summer temperatures are projected to rise by about 3°F (1.7°C) by the 2040s, and 5–6°F (2.8-3.3°C) by the 2090s (Scenarios Network for Alaska and Arctic Planning, 2011). Precipitation patterns are also expected to change, with 20-45% increased winter precipitation by the 2040s, and 35-70% increases in the 2090s; summer precipitation increases would be smaller. A northward shift in thaw dates is expected over the course of the century with thawing occurring in the coastal regions during the first week of June by mid-century and June 1 by the end of the century; while thaws would occur around May 1st in the southern NPR-A. In comparison, fall freeze-up dates along coastal areas would extend into late September, and October 1st in the Brooks Range. Consequently growing seasons could grow by another 6 weeks in the northern portions of the Western ACP, and by 3 weeks in the mountains of the Brooks Range (Scenarios Network for Alaska and Arctic Planning, 2011). Most of the western ACP is expected to remain within the existing temperature and precipitation ranges; but by century's end, conditions in the southern areas of the ACP (Brooks Mountains) would better match those presently found in warmer areas of Alaska. These climatic changes would lead to alterations in the vegetative communities which could have a profound impact on terrestrial mammals and productivity in the area.

Such impacts could include incursions of shrubs and trees in to areas that were formerly tundra-dominated; the replacement of existing ecological communities with new and novel ones; the arise of new ecosystems; the introduction of new diseases into the region, and the appearance of new mammal species, loss of existing mammal species, and range shifts for others.

5.2.7.3. Analysis of Cumulative Impacts

Caribou

Caribou can be affected by the loss of sea ice in the Arctic. As sea ice losses continue to increase, larger storm events may occur throughout the Arctic Ocean, and without sea ice to moderate the effects of winds on water, large waves and swells would develop which could destroy a significant amount of coastal habitat over time. Increases in growing season length, temperatures, permafrost thawing, and increased precipitation could be advantageous to the production of vascular forage plants on summer ranges; however, the increase in vascular range plants would result in a corresponding loss to non-vascular winter range plants such as lichens, which could be detrimental to caribou. An effect of longer, warmer growing seasons with a deeper layer of thawed permafrost is increased root production by vascular plants, and a shift to earlier emergence of plants that could lead to a trophic-mismatch between plant development, nutritional quality of plants, and caribou calving and grazing (Kerby and Post, 2013). Increasing fire frequency is a characteristic of climate change in the Arctic and could lead to the long-term destruction of caribou winter ranges that may take 50 years or more to recover from (Joly, Duffy, and Rupp, 2012; Gustine et al., 2014).

In recent years, shrubs and trees have been observed growing in places where they previously did not exist, and the potential for shrub and tree encroachment into the Arctic has become a cause for concern (McNew et al., 2013). The successful development of new plant communities, and the northward advance of trees and shrubs would depend on the genetically regulated abilities of a species to adapt to new environmental conditions (Nicotra et al.; 2010; Shaw and Etterson, 2012; Franks and Hoffmann, 2012). Consequently there may be genetic limitations to how far north a plant species can grow, an environmental limitation other than temperature and precipitation; meaning trees and shrubs in northern Alaska may lack the genetic flexibility necessary to germinate and grow along the Chukchi and Beaufort Sea coastlines or on the ACP.

Kaarlejärvi (2014) determined herbivores such as reindeer (caribou), and microtines can prevent lowland forbs from invading areas of open tundra through herbivory, and that herbivores counteract the effects of climate warming by slowing or preventing the invasion of new plant species into tundra systems. Cahoon et al. (2012) determined large herbivores can mediate the responses of Arctic ecosystems to climate change through herbivory. Thus, maintaining healthy populations of caribou, and other large herbivores in the Arctic may offset many of the ecological effects of climate change such as shifts in diversity, invasion by novel new species, transitions to novel new ecological communities, etc.

Recently, the topic of winter rain-on-snow event degradation of caribou winter ranges has been discussed. Little empirical evidence supporting such a view exits, and Tyler (2010) concluded the effects of climate variability on caribou are “dwarfed” by the effects of density-independent factors of politics, social issues, and economics.

Changes in local economics within Arctic communities are likely to have some effects to caribou into the future. Increased financial resources would allow subsistence users to remain in the field longer, purchase better equipment, and improve their hunting success; however, increased financial resources would also allow communities to purchase more non-subsistence foods that could remove some dependency on subsistence foods, which could result in less subsistence activity.

Recreational use of caribou from the Western Arctic (Caribou) Herd (WAH) is likely to decrease in response to a dwindling herd size, and the increasing costs involved with accessing the WAH for sport hunting. Military and USCG operations on the ACP may have some minor effects on caribou, the primary impact being elevated levels of aircraft traffic which could be deleterious to caribou until they habituate to aircraft noise and presence (Wolfe, Griffith, and Wolfe, 2000). Other sources of aircraft traffic that could affect caribou would include more commercial flights into and out of North Slope communities, and flights supporting future industrial developments that are unrelated to the Proposed Action. Increasing numbers of vehicles, roads and pipelines in association with onshore oil and gas developments are anticipated, as are the construction of infrastructure and facilities to support onshore oil and gas operations.

Climate change effects across the North Slope would have mixed effects on caribou; effects that are expected to be greater than all of the past, present, and foreseeable human activities combined. The effects of the Proposed Action on caribou would be negligible and would not appreciably add to, subtract from, or synergistically interact with the major level of effects from climate change or the minor to moderate effects of other past, present, or reasonably foreseeable future activities on caribou of the WAH, the Teshekpuk Lake Caribou Herd, and the Central Arctic Caribou Herd during the 21st century.

Muskox

Muskox can be affected by the loss of sea ice in the Arctic. As sea ice losses continue to increase, larger storm events may occur throughout the Arctic Ocean, and without sea ice to moderate the effects of winds on water, large waves and swells would develop which could impact coastal habitat over time. Increases in growing season length, temperatures, permafrost thawing, and increased precipitation could be advantageous to the production of vascular forage plants on summer ranges, which would be a positive effect for muskoxen. An effect of longer, warmer growing seasons with a deeper layer of thawed permafrost is increased root production by vascular plants, and a shift to earlier emergence of plants that could lead to a trophic-mismatch between plant development, nutritional quality of plants, and muskox calving and grazing as Kerby and Post (2013) observed for caribou. However, the non-migratory behavior of muskoxen may prevent trophic-mismatches between muskox and their forage species. Increasing fire frequency could lead to the long-term destruction of musk ox winter ranges; however, seral stages that follow Arctic wildfires would include graminoid, forb, and shrub communities that could favor muskoxen.

Changes in long term flora on the North Slope could affect Arctic herbivores. In recent years, shrubs and trees have been observed growing in places where they previously did not exist. The potential for shrub and tree encroachment into the Arctic has been a cause for concern (McNew et al., 2013); however, the development of new plant communities, and the northward advance of trees and shrubs would depend on genetically regulated abilities of each species to adapt to new environmental conditions (Nicotra et al.; 2010; Shaw and Etterson, 2012; Franks and Hoffmann, 2012). Consequently, genetic limitations may limit how far north a plant species can grow; meaning trees and shrubs in northern Alaska may lack the genetic flexibility necessary to germinate and grow along the Chukchi and Beaufort Sea coastlines or on the ACP. With a mixture of habitat, muskoxen would ideally graze sedge meadows on the ACP in summer, and use shrublands during winter for cover and browse from time-to-time.

Kaarlejärvi (2014) determined mammalian herbivores can prevent lowland forbs from invading areas of open tundra through herbivory, and that herbivores counteract the effects of climate warming by slowing or preventing the invasion of new plant species into tundra systems. Cahoon et al. (2012) determined large herbivores can mediate the responses of Arctic ecosystems to climate change through herbivory. Thus maintaining healthy populations of muskoxen, and other large herbivores in the Arctic may offset many of the ecological effects of climate change such as shifts in diversity, invasion by novel new species, transitions to novel new ecological communities, etc. Under the current climate change projections muskoxen numbers may actually increase along the North Slope.

Recently, the topic of winter rain-on-snow event degradation of caribou winter ranges has been discussed; however, muskoxen rely on stored reserves during much of the winter and generally do not browse or graze extensively. Consequently, the effects of icing on muskox winter habitat would likely be negligible, and since muskoxen prefer “shrubby” habitat that is increasing in some areas of Arctic Alaska some positive effects to muskoxen may occur through the creation of new habitat.

Changes in local economics within Arctic communities are likely to have some effects to muskox into the future. Increased financial resources would allow subsistence users to remain in the field longer, purchase better equipment, and improve their hunting success; however, increased financial resources would also allow communities to purchase more non-subsistence foods that could remove some dependency on subsistence foods, which could result in a smaller subsistence harvest on muskoxen.

Recreational use of muskox may increase or decrease in response to fluctuations in the numbers of muskoxen, and the increasing costs involved with accessing the animals for sport hunting. Furthermore, military and USCG operations on the ACP may have some minor effects on muskox. The primary impact from onshore military and USCG operations would be elevated levels of aircraft traffic which would be deleterious to muskox until they habituate to aircraft noise and presence. Other sources of aircraft traffic that could affect muskox would include more commercial flights into and out of North Slope communities, and flights supporting future industrial developments that are unrelated to the Proposed Action. Increasing numbers of vehicles, roads and pipelines in association with onshore oil and gas developments are anticipated, as are the construction of infrastructure and facilities to support onshore oil and gas operations.

Climate change effects across the North Slope would have a mixed effect on muskoxen; effects that are expected to be greater and more profound than all of the past, present, and foreseeable human activities combined. The effects of the Proposed Action on muskox would be negligible and would not appreciably add to, subtract from, or synergistically interact with other past, present, or reasonably foreseeable future activities, or climate change, to alter the condition of muskox during 21st century, which in total represent minor impacts.

Grizzly Bear

Grizzly bears can be affected by climate change in the Arctic. As sea ice losses continue to increase larger storm events may occur throughout the Arctic Ocean, and without sea ice to moderate the effects of winds on water, large waves and swells would develop which could impact coastal habitat over time. Such storms are more likely to deposit marine mammal carcasses and other food resources onshore that would have a positive effect on grizzlies scavenging carrion.

Increases in growing season length, temperatures, permafrost thawing, and increased precipitation could be advantageous to the production of vascular forage plants on summer ranges, which would be a positive effect for grizzlies. One effect of longer, warmer growing seasons with a deeper layer of thawed permafrost is increased root production which leads to shifts from non-vascular plants to vascular plants, and a shift to earlier plant emergence that could become an important source for grizzly bears emerging from hibernation. Increasing fire frequency could lead to the conversion of moss and lichen-dominated ecological communities, to graminoid and forb-dominated ecological communities.

Changes in long term flora on the North Slope could affect prey species such as Arctic ground squirrels, muskox, moose, and caribou. In recent years, shrubs and trees have been observed growing in places where they previously did not exist. The potential for shrub and tree encroachment into the Arctic has been a cause for concern (McNew et al., 2013); however, the development of new plant communities, and the northward advance of trees and shrubs would depend on genetically regulated abilities of each species to adapt to new environmental conditions (Nicotra et al.; 2010; Shaw and Etterson, 2012; Franks and Hoffmann, 2012). Grizzlies would respond to the probable future fluctuations in prey species numbers by switching to other food sources such as salmon which are likely to numerically increase. They may also shorten their denning period in response to climate change effects to the duration and severity of winter. Under the current climate change projections, grizzly numbers could increase throughout the North Slope, providing they have access to sufficient numbers of prey animals and forage plants.

Changes in local economics within Arctic communities are likely to have some effects to grizzly bears into the future. Increased financial resources would allow subsistence users to remain in the field longer, purchase better equipment, and improve their hunting success; however, increased financial resources would also allow communities to purchase more non-subsistence foods that may decrease some dependency on subsistence foods, which could result in a smaller subsistence harvest on grizzlies.

Recreational hunting of grizzly may increase or decrease in response to grizzly population fluctuations. The increasing costs of accessing them for sport hunting may also play a role. Furthermore, military and USCG operations on the ACP may have some minor effects on grizzly bears. The primary impact from onshore military and USCG operations could be elevated levels of aircraft traffic which would be deleterious to grizzly until they habituate to aircraft noise and presence. Other sources of aircraft traffic that could affect grizzlies would include more commercial flights into and out of North Slope communities, and flights supporting future industrial developments unrelated to the Scenario. Increasing numbers of vehicles, roads, and pipelines in association with onshore oil and gas developments are anticipated, as are the construction of infrastructure and facilities to support onshore oil and gas operations.

Climate change effects across the North Slope would have a mixed impact on grizzly bears and these impacts are expected to be greater than all of the other past, present, and foreseeable human activities combined. The effects of the Proposed Action on grizzlies would be negligible and would not appreciably add to, subtract from, or synergistically interact with the minor, but positive, climate change effects, and other negligible effects from past, present, or reasonably foreseeable future activities on North Slope grizzly bears during 21st century.

Furbearers

Furbearing mammals such as wolves, wolverines, Arctic foxes, red foxes, and lynx can be affected by climate change in the Arctic. As sea ice losses continue to increase, larger storm events may occur throughout the Arctic Ocean. Without sea ice to moderate the effects of winds on water, large waves and swells would develop which could destroy a significant amount of coastal habitat over time. Such storms are more likely to deposit marine mammal carcasses and other food resources onshore, which would be a positive effect for furbearers that scavenge carrion. Another positive benefit of climate change on furbearers would be the increased biological productivity that a warming climate would have throughout the terrestrial plant communities. Such productivity would initially include increased plant vegetative production, which in turn would provide increased forage for herbivores. Healthier and more abundant prey species, or new prey species, would then have beneficial effect on furbearing mammals such as foxes, wolves, wolverines, etc., through a more diverse diet having increased caloric value. For example, a decrease in caribou numbers might be compensated for by increases in rodent, muskox, moose, or sheep numbers due to better range conditions and milder temperatures. For furbearers having a resident population of prey species to rely upon rather than migratory caribou, it could mean consistent, high-quality nutrition throughout the year, rather than hunger interspersed with periodic episodes of feasting when caribou calve or migrate through an area, or when carrion becomes available.

Changes in local economics within Arctic communities are likely to have some effects to furbearers into the future. Increased financial resources would allow subsistence users and trappers to remain longer in the field, procure better equipment, and improve their trapping success. For trappers, this would then increase revenues within households.

Military and USCG operations on the ACP may have some minor effects on furbearers. The primary impact from onshore military and USCG operations would be elevated levels of aircraft traffic which could be deleterious to wolves, wolverines, and foxes until they habituate to aircraft noise and presence. (Manci et al., 1988; Churchill and Holland, 2003). Increasing numbers of vehicles, roads, and pipelines in association with onshore oil and gas developments are anticipated, as is the construction of infrastructure and facilities to support onshore oil and gas operations. As with military infrastructure, developments such as buildings, berms, and other modifications to the landscape could provide foxes with new denning areas, which would have a positive effect of fox populations.

Climate change effects across the North Slope would have a positive impact on most furbearing mammals; effects that are expected to be greater than all of the past, present, and foreseeable human activities combined. Increases in red fox numbers would likely result in lower numbers of Arctic foxes since red foxes predate and out-compete Arctic foxes in most areas where these species coexist. The effects of the Proposed Action on all furbearers would be negligible and would not appreciably add to, subtract from, or synergistically interact with other past, present, or reasonably foreseeable future activities, or climate change, to alter the condition of furbearers during 21st century.

5.2.7.4. Summary/Conclusion

Caribou

The effects of climate change on caribou populations would likely lead to a decrease in herd sizes over the 21st century due to winter habitat losses, limited shrubland expansion onto the North Slope, and conversions of non-vascular and wetland plant communities to graminoid/forb-dominated communities. Retaining large herbivores on the landscape may mitigate some level of shrubland expansion; however, these changes are expected and collectively would have a major level of effect on caribou. The human activities that are expected to occur should have minor to moderate levels of effect on caribou. While the contribution of the Proposed Action to effects on caribou of the WAH and TCH would be minor, the anticipated cumulative effects of past, present and reasonable foreseeable future activities would represent a major level of effects due to the effects of climate change.

Muskox

The effects of climate change on muskox populations could lead to stable or increasing herd sizes over the 21st century due to longer growing season, limited shrubland expansion onto the North Slope, and conversions of non-vascular and wetland plant communities to graminoid/forb-dominated communities which would provide more forage. The human activities that are expected to occur should have negligible to minor levels of effect on muskox, while the Proposed Action would contribute a negligible level of effect. The cumulative effects of past, present, reasonably foreseeable activities, and the Proposed Action would amount to a minor level of effects on muskox.

Grizzly Bear

Climate change would have minor, positive impacts on grizzly populations. Effects would likely include slight population increases over the 21st century due to improved biological productivity and the potential for larger Arctic ground squirrels, larger salmon runs, increased marine mammal carrion, etc. The human activities that are expected to occur would result in a negligible level of effect on grizzly populations, as would the Proposed Action. The contribution of the Proposed Action to cumulative effects of past, present, reasonably foreseeable activities, and climate change, amount to a minor level of beneficial effects on grizzly bears on the ACP and North Slope of Alaska.

Furbearers

Climate change would have a minor, positive level of effects on furbearer populations on Alaska's North Slope. Effects would likely include population increases over the 21st century due to improved biological productivity, increased marine mammal carrion, habitat changes, etc. The human activities that are expected to occur should have a negligible level of effect on most furbearer populations, as would the Proposed Action. Foxes are an exception, and onshore infrastructure development would have a minor positive level of effect of Arctic foxes and red foxes. The contribution of the Proposed Action to the cumulative effects of past, present, reasonably foreseeable activities, and climate change, would amount to a minor level of beneficial effects on furbearers on Alaska's North Slope.

5.2.8. Vegetation and Wetlands

5.2.8.1. Summary of Direct and Indirect Effects

The effects to vegetation and wetlands of the Proposed Action include loss of vegetation and wetlands, damage to vegetation cover, shift in plant-species composition, introduction of non-native plants and noxious weeds, accidental spills of small and large refined products, or large oil spills onshore or/and offshore. These effects would be primarily caused by construction, operation and maintenance of the coastal facilities, gravel material sites, and the overland oil and gas pipelines.

Vegetation and wetlands would be lost from the placement of gravel to construct pads and roads, and excavation of wetlands to obtain the underlying gravel. Vegetation and wetlands are susceptible to damage from temporary compression caused by ice pads and ice roads, and loss of habitat from traffic dust from gravel roads and pads. Run-off from roads and pads would also impact vegetation and wetlands and could alter the species composition of plants. Another impact could result from hydrologic changes due to fill placement inducing changes in surface flow. In general, most changes in the plant community and soil around gravel structures would occur within 160 feet of the structure (Walker and Everett, 1987). Native plant communities could be replaced by early-successional colonizers and species more tolerant of the altered site conditions.

5.2.8.2. Discussion of Other Relevant Actions

Past and Present Actions

North Slope vegetation and wetlands have been impacted by non-oil and gas activities as well as those relating to oil and gas activities. Non-oil and gas activities, including archaeological and paleontological digs, camps associated with scientific studies, recreational use, overland moves by transport vehicles, and use of off-highway vehicles such as four-wheel vehicles and snowmachines, have likely caused the loss of less than 100 acres of vegetation and wetlands in the NPR-A, according to the BLM (2012). Approximately 2,500 acres on the North Slope (1,800 acres of village and public facilities, and 700 acres of military facilities) have been directly impacted by these actions, and an additional 4,630 acres of wetland are indirectly affected by human activities occurring off gravel roads and pads, and this loss of vegetative cover is likely to persist into the indefinite future. Oil and gas infrastructure accounts for the largest past and present impacts to vegetation on the North Slope. BLM has estimated that through 2012, the footprint of oil and gas activities on the North Slope (to include roads, pads and oil fields near the Dalton Highway) is approximately 18,150 acres, and the total long-term impacts to wetlands from past and present oil and gas activities on the North Slope covers approximately 36,800 acres.

Reasonably Foreseeable Future Actions

The amount of area on the North Slope that would be disturbed by non-oil and gas activities is projected to increase by about 2% annually, approximately doubling to 3,600 acres by the mid-21st century when human population may level off (USDOI, BLM, 2012).

- A continued loss of minor amounts of vegetation would be expected on the North Slope from archaeological and paleontological digs, camps associated with scientific studies, recreational use and other activities, overland moves by transport vehicles, and use of off-highway vehicles such as four-wheel vehicles and snowmachines. In most cases, loss of vegetation would be temporary, lasting only a few years.
- Villages are likely to increase in size, causing the loss of additional vegetation and wetlands.
- Air Force Radar Sites are not likely to expand. Other military facilities, villages, airstrips, and other non-oil and gas infrastructure are likely to persist into the indefinite future.

North Slope oil and gas development activities that could contribute to cumulative effects to vegetation analyzed by BLM (2012) include:

- The footprint of the Umiat Road, pipeline, road and ancillary facilities would be approximately 850 acres with material sites impacting an additional 175 acres. An oil pipeline along the same route would add up to 2 acres of disturbance from the placement of vertical support members. A gas pipeline would be buried and would affect about 185 acres (trench and temporary spoils storage) for the long-term through trenching and temporary storage of spoils, while another 620 acres would receive short-term impacts from construction of an ice road.

- Other Developments associated with a pipeline across the NPR-A could make additional developments within the NPR-A more economical, causing a synergistic increase in acres of vegetation affected (i.e., it could total more than the currently assumed acres from the NPR-A development Scenario and the Chukchi Sea development Scenario). The amount of acres that would be lost is uncertain.
- Beaufort Sea Development - Up to 85 miles of onshore pipelines would be required, affecting less than one acre of vegetation through vertical support member placement. Offshore development in the Beaufort Sea would require onshore processing facilities only if offshore platforms were too far from the coast for transport of multi-phase produced fluids to shore.
- Commercial Gas Pipelines - Construction of gas pipelines could have long-term effects on up to 4,500 acres of vegetation, and pipeline operation after construction might affect only half that many acres. Actual gravel footprint is estimated at only 350 acres, with an additional 35 acres of new material sites.
- Conventional Oil and Gas Development between the Colville and Canning Rivers - If the current rates continue into the future for areas east of the NPR-A, and the ratio of gravel mine acres to gravel footprint acres remains about 5:1, about 3,750 additional acres would be covered by gravel for construction of pads, roads and airstrips and 750 acres would be impacted by gravel mines through the Year 2100.
- Unconventional Oil and Gas Development between the Colville and Canning Rivers - This would result in a total of 3,600 acres of additional vegetation destruction over 15 years to the cumulative total, and approximately 21,600 acres of vegetation change through dust and moisture regime changes.
- Spills and Gas Releases - The number of large spills (more than 500 barrels) on the North Slope between 2012 and 2100 is assumed to be 20. BLM (USDOI, BLM, 2012, Section 4.8.7.5) assumes that all of the spills would reach the tundra. However, the high variability in amount of land affected by each large spill, large spills are relatively rare, there is high variability of areal extent, and insufficient data to estimate an average area covered. Any accidental gas releases that occur in the future would affect vegetation only if the gas ignites and burns; impacts to tundra vegetation from gas releases would not accumulate.
- Non-native Invasive Plant Species - No non-native invasive plants have been documented in the current oil fields, although some occurrences have been documented along the Dalton Highway. Specific efforts have not been made to detect their presence in the oil fields.
- Air Quality - Emissions on the North Slope are expected to decrease, due to an overall downward trend in oil production. Greater reliance on technologies that reduce the need for permanent roads and pads, and reduce the size of the facility footprint, also would result in lower levels of particulate matter emissions. Still, impacts to vegetation from past and future air pollutants could accumulate (USDOI, BLM, 2012, Section 4.8.7.5).
- NPR-A Oil and Gas Leasing Activities – According to the BLM, impacts from ice road, ice pad, and ice airstrip construction would occur on 232,710 to 458,003 acres of vegetation; these impacts would be short term and would not accumulate (USDOI, BLM, 2012). Long-term impacts to vegetation and wetlands from seismic surveys in the NPR-A would occur on approximately 1,670 acres. Development in the NPR-A could cause long-term impacts on approximately 8,402 acres, and indirectly impact 23,596 acres of vegetation. Indirect impacts may include the potential for the introduction and spread of non-native invasive species. Impacts would be long-term and would accumulate. Total, long-term impacts to vegetation from

exploration and development combined would occur on more than 0.12% to less than 0.26% of the NPR-A.

Climate Change

The BLM (USDOI, BLM, 2012) also presented the most up-to-date discussion of cumulative effects from climate change regarding vegetation for the area that includes the majority of area that would be impacted by coastal facilities and pipeline corridor described by the Scenario for this Second SEIS. BLM indicates tundra habitats have changed and would continue to change. Perhaps the most important changes to vegetation in the Arctic are expected in the form of expanding and retreating lakes and wetlands. Much of the ACP is underlain with permafrost. Permafrost close to the surface plays a major role in freshwater systems, because it often maintains lakes and wetlands above an impermeable frost table, which limits the water-storage capabilities of the subsurface.

As the current pattern of warming continues, some regions of the Arctic would see shifts in permafrost distribution and deepening of the active layer, accompanied by changes in vegetation. The active layer is the topmost layer of permafrost that thaws during summer, allowing organic processes to occur. As the active layer becomes saturated, it is prone to collapse (mass wasting). Permafrost collapse tends to result in the slumping of the soil surface and flooding followed by a complete change in vegetation, soil structure, and many other important aspects of these ecosystems. Flooding initially results in a boost of vegetative productivity and the expansion of wetlands and shallow lakes. As the permafrost continues to melt, however, and infiltration increases, shallow summer groundwater tables continue to drop, which can cause drying of wetlands and drainage of lakes.

Satellite and field data have revealed changes in the number and total area of lakes in the Arctic and wetlands in just the past few decades (BLM 2012). A preliminary assessment is that wetlands are growing in northern areas of continuous permafrost, but disappearing farther south. Lakes in areas of continuous and discontinuous permafrost have experienced substantial shrinkage, likely due to permafrost degradation allowing them to drain to the subsurface. A study of lakes in Siberia observed that many lakes have disappeared or shrunk in the last 30-40 years (Smith et al., 2005).

In BLM’s discussion of climate change for the NPR-A, sea level rise is regarded as one of the more certain consequences of climate change. During the past 100 years, sea level has risen at an average rate of about 1-2 mm per year (or 4-8 in per century) (Walsh et al., 2014; Titus and Narayanan, 1995). Global average sea level rise is forecasted by Walsh et al. (2014) to rise one to four feet by 2100; such a change may inundate low-lying tundra areas, wetlands would be forced farther inland, tundra eroded and existing coastal wetlands would experience subsidence (ACIA, 2004).

Coastal wetlands are particularly vulnerable to sea level rise associated with increasing global temperatures (USDOI, BLM, 2012). Freshwater systems in the Arctic are dominated by a low-energy environment and cold region processes. Changing rates and timing of river runoff would alter the temperature, salinity, and oxygen levels of coastal estuaries. Inundation by rising sea levels, intensification of storms, and higher storm surges threaten coastal estuaries and wetlands. For many of these systems to persist, a continued input of suspended sediment from inflowing streams and rivers is required to allow for soil accretion.

5.2.8.3. Analysis of Cumulative Impacts

The total amount of vegetation and wetlands on the North Slope impacted by oil and gas development and other activities is anticipated to increase. Wetland loss, disturbance, and degradation occurring as a result of the Scenario would be additive to the impacts from past, present, and reasonably foreseeable actions. The area of vegetation impacted by oil and gas exploration and development, compared to the amount of available habitat on the ACP in Alaska and on the North Slope as a whole, is relatively small. Impacts on vegetation caused by the Scenario and other present and future oil activities could accumulate and persist, especially if structures remain once industrial activity has ceased. Impacts associated with the possible construction of the pipeline would be additive to the existing infrastructure already in place on the North Slope and the reasonably foreseeable future activities listed above.

5.2.8.4. Summary/Conclusion

Impacts to vegetation of Alaska's North Slope from the Scenario are expected to add to the impacts associated with other activities. Impacts to the vegetation and wetlands from oil and gas development and other activities are anticipated to continue into the future. Many of these impacts would be permanent, but it is anticipated that some disturbances to vegetated communities would be restored. While the cumulative impacts from the Scenario and other past, present, and reasonably foreseeable actions are additive, the total amount of disturbance area is small compared to the total amount of wetlands on the ACP. Therefore, the overall contribution of the Proposed Action to cumulative effects to vegetation is minor. It is anticipated that the environmental changes associated with Arctic climate change would, in the long run, have the greatest potential to impact vegetation and wetlands on the North Slope.

5.2.9. Economy

5.2.9.1. Summary of Direct and Indirect Effects

The Proposed Action would impact the economy by generating employment, personal income, and government revenues. These activities would impact the economies of the North Slope Borough (NSB), the State of Alaska, and the United States. The manpower needed to conduct these activities and the impacts on revenue from the development of onshore infrastructure are expected to be substantial, given the nature, scale, and duration of these activities. This especially holds when considering economic effects of large new projects in a frontier region like the Chukchi Sea with significant environmental and logistical challenges. The overall direct and indirect employment, labor income, and revenue effects from the Proposed Action in the region would be major.

5.2.9.2. Discussion of Other Relevant Actions

Infrastructure development projects generate economic activity in the form of employment, labor income, and property tax revenues. Past, present, and reasonably foreseeable infrastructure development projects that are currently underway in the region or are expected to occur in the foreseeable future include oil and gas development projects. These projects include the Point Thomson, Liberty, and Greater Mooses Tooth projects, and the development of smaller accumulations of oil expected to be discovered and produced in the next 10 years. For a description of these projects, please refer to Section 5.1.2 and Tables 5-3 and 5-4.

Other activities that currently exist at relatively low levels in the Arctic (if they exist at all) are expected to increase as the distribution of sea ice in the region changes. These activities would also have economic impacts. These activities include potential future commercial fishing, increased recreational fishing, mining, renewable and nonrenewable energy development, tourism, recreation, and marine shipping. These activities would require substantial levels of skilled labor and high value infrastructure.

Fluctuations in the population of the region are likely to continue as trends in migration evolve. It is uncertain at this time how community development would proceed given changes in net migration. Out-migration from rural communities to urban communities throughout Alaska has been driven in recent years by education and economic opportunities. Future community infrastructure and renewable and nonrenewable energy development projects that generate personal income and government revenues could facilitate the option for local governments and residents to invest in improved education and economic opportunities which could lead to population increases. As population increases, so does demand for public services and infrastructure.

Increased revenues could be used to create or enhance infrastructure such as:

- Existing housing, water supplies; waste storage and disposal
- Electricity, fuel and communication systems
- Deep water ports to accommodate increased marine vessel traffic
- Access to dock and port space
- Permanent and temporary roads
- Airstrips to accommodate larger planes
- Infrastructure for logistical, search and rescue, and military support for onshore and offshore development projects.

As discussed in Section 5.1.2, BOEM also estimates that future lease sales in the Chukchi Sea could result in an additional 1.9 Bbbl of oil and 2.1 TCF of gas from the development and production of two additional satellite fields. These activities would increase employment and personal income as additional workers would be needed to modify, expand, and develop new infrastructure in support of of the two satellite fields as production from the Lease Sale 193 leases declines. A small increase from the additional manpower required to expand and modify the existing shore base to support additional oil and gas production would continue during the transition period, where both oil and gas would be produced from offshore platforms, and then taper off in later years of production back to the levels provided in the Scenario in Table 2-3 of this Second SEIS. The employment, personal income, and revenues generated from the development of future leases would be less than that from the Proposed Action, because some of the infrastructure needed to develop the two additional satellite fields would already have been built.

The Alaska LNG Pipeline Project (AK LNG), described in Section 2.3.5 (Development and Production), is expected to occur during the same timeframe as the activities associated with the Proposed Action. This AK LNG would require substantial manpower and infrastructure. Any onshore infrastructure associated with the Proposed Action that remains in place to be used for future onshore or offshore oil and gas production would generate property tax revenues for the State and local governments by extending the useful life of that onshore infrastructure. The AK LNG would require a substantial amount of skilled labor, generating increases in employment and personal income, and also putting a strain on the supply of skilled labor in the region.

5.2.9.3. Analysis of Cumulative Impacts

Increased employment and resulting increased population from the Proposed Action and other relevant reasonably foreseeable future actions would lead to increased demand for public services and infrastructure in the NSB. As described above, this includes increased demand for housing, water, waste disposal and storage, electricity, telecommunications, port/dock access, roads, and additional and larger airstrips to accommodate increased air traffic from larger planes, among others. Population increases could also lead to future demographic changes as the region experiences an influx of outside cultures. This effect would likely be offset in part by the nature of enclave development of additional housing and support services required by the influx of direct and indirect workers. The activities described above would require skilled labor and high value infrastructure, causing synergistic effects with the effects of the Proposed Action, as much of the skilled labor and onshore infrastructure needed for the Scenario would also support other development.

This increase in population and corresponding demand for public services and infrastructure could also cause boom and bust cycles. The development of Prudhoe Bay and the TAPS caused wide fluctuations in the population of the NSB and the State of Alaska and increased the demand for services and infrastructure to accommodate the rising population. Population growth during the 1970s and early 1980s was driven primarily by two converging factors: high oil prices and increases in the birth rate from those who settled in Alaska during the initial boom. As the activities associated with the Proposed Action wind down, the NSB and the State of Alaska could experience a net migration loss, leaving under-utilized or unused public services and infrastructure behind. Boom and bust cycles could also lead to local economies overheating from inflation caused by rapidly increasing wage growth and increasing prices in the NSB and State.

5.2.9.4. Summary/Conclusion

The Reasonably Foreseeable Future Actions described above would generate economic impacts that are additive, synergistic, and countervailing to those from the Proposed Action, which itself would contribute major effects.

5.2.10. Subsistence-Harvest Patterns

5.2.10.1. Summary of Direct and Indirect Effects

The Scenario could disrupt sociocultural systems by disrupting subsistence harvests in the marine environment or on land through making a subsistence resource undesirable or unavailable for use, resulting in subsistence harvesters avoiding or being unable to harvest the affected resource. Industrial activities that could impact subsistence-harvest patterns include but are not limited to:

- Transportation, either by vessel or aircraft
- Excavation for oil and gas pipelines on- and offshore
- Construction of oil and gas pipelines on- and offshore
- Construction of exploration and production shore bases
- Construction of pump stations
- Construction of roads
- Construction of infrastructure – (gravel mine sites, ports, docks, airports, hangars, landing strips, and the like)

Combined effects from OCS oil and gas activities over the life of the Scenario are anticipated to range from minor to major, depending on individual species and level of mitigation. Periods of exploration, drilling, and construction activity would likely have a localized, short-term effect on communities due to potential harvest disruptions. The construction of shore base facilities and pipeline corridors could result in more extensive alterations to existing subsistence-harvest patterns through:

- Anthropogenic noise resulting in subsistence species avoidance/deflection
- Presenting barriers to subsistence-harvest patterns
- Perceived contamination of some subsistence-harvest resources (as an example, fugitive dust on greens or berries)

If production occurs, subsistence-harvest impacts (such as traveling longer distances to harvest subsistence species) could be major, though offset by potential economic revenue. The greatest degree of impacts could occur from large spills, which could cause long-term tainting or perceived tainting of subsistence resources, making them unavailable or undesirable for use. The highest likelihood of adverse impact occurs from Years 10-50, where exploration activities overlap with development and production activities. Once exploration drilling ceases, operational adverse impacts would likely decline (in the absence of a large spill), with lower levels of effect, although weekly or daily air and marine transportation will increase and continue unabated until decommissioning.

As examples of avoidance, if the shore base is at Point Belcher, all air and vessel traffic should travel in corridors that completely avoid the area documented as most frequently used by marine subsistence hunters (Braund, 2013a). Any action that could create a barrier to subsistence harvests would also need to be mitigated through avoidance. An effective method for communicating with local subsistence harvesters on land would be signage in the Iñupiaq language to indicated road crossings or a pipeline. An effective method for communicating with local marine or terrestrial subsistence hunters would be through establishing communication call centers in the local community, staffed with operators fluent in English and Iñupiaq, who would be in constant radio or cell phone contact with hunters and industry to ensure that conflict should not arise between subsistence and industrial use. An applicable lease stipulation would be Stipulation No. 5, Conflict Avoidance Mechanisms to protect Subsistence Whaling and Other Subsistence-Harvesting Activities, particularly because in three seasons, on-ice bowhead whaling camps were established offshore of Point Belcher. Implementation of the terms and conditions of the 2013 NMFS Biological Opinion would likely reduce potentially major impacts to moderate or even minor levels for all OCS oil and gas activities, except spills. In the latter instance, the effect could be major, depending on the volume spilled, the time of year the spill occurred, the location, sea states, ice conditions and many other variables that are unpredictable.

5.2.10.2. Discussion of Other Relevant Actions

Past, present and reasonably foreseeable infrastructure development projects along the Bering Sea coast and across the North Slope include: oil and gas development projects, community development, and mining projects. These various development projects are described in Section 5.1.2 and Tables 5-3 and 5-4. Such substantial actions, in combination with anticipated growth in vessel traffic, homeland security or military activities, and regional recreation and tourism would likely generate additional disturbance to wildlife and could affect subsistence activities through displacement, altered habitat, threat of contamination, or other disruption to traditional living.

As an example of anticipated growth in homeland security or military activities that could affect subsistence, USCG coastal patrols could mitigate impacts by avoiding subsistence hunters (SRB&A, 2013a). Flights associated with wildlife monitoring on land and sea could be coordinated to avoid conflicts with subsistence hunters (SRB&A, 2013a and 2013b). Thus, unintended consequences of resource mitigation and monitoring efforts need to be considered with subsistence in mind. The military will continue to be a presence in the project and surrounding areas. At least nine Distant Early Warning sites dotted the coastline from the Canadian border to the Chukchi Sea in the past. These stations were constructed between 1954 and 1957, and decommissioned in the 1990s. Many of these sites have been remediated, and decommissioning efforts might continue, including demolition. It is likely that the military vessels will be deployed from a harbor south of the Leased Area that would be developed as a port. This port would be unlikely to affect subsistence harvesters residing along the shores of the northwestern Chukchi Sea.

Currently, there are 35 fields producing oil on the North Slope and in nearshore areas of the Beaufort Sea, and additional discoveries are under development. North Slope oil and gas exploration, development, and production activities include the construction and operation of TAPS, permanent roads, winter ice roads, construction of support facilities, and transportation activities involving surface vehicles, aircraft, or marine traffic along the coast or within the barrier islands.

Oil and gas exploration and development have occurred in the past, are occurring now, and are reasonably foreseeable to occur in the future. Leased Area activities would elicit interest that could result in additional lease sales in the OCS, and these could create synergistic and additive effects. OCS development at the Liberty prospect in the Beaufort Sea is expected to occur during the life of the Proposed Action. Onshore oil and gas activities would include the Alaska Pipeline Project near Prudhoe Bay, with facilities to treat, transport, and deliver gas from the North Slope of Alaska to markets in North America and possibly overseas. These facilities could include the installation and operation of a gas treatment plant at Prudhoe Bay with construction targeted in the 2020s. The Point Thomson project, located approximately 60 miles east of Prudhoe Bay, could include the construction of three production pads, process facilities, an infield road system, an export pipeline, infield gathering lines, and an airstrip. The effects on subsistence harvests would need to be assessed to reduce impacts to minor or moderate levels and reduce the level of potential conflicts that could arise.

Mining activities in the leased and surrounding area include the following:

- Southwest Chukchi Sea, inland, Red Dog Mine
- Southwest Chukchi Sea coastal, Red Dog Port
- Western Chukchi Sea coastal, Western Arctic Coal project

The former could experience expansion, and the latter would capitalize on a known coal prospect that was mined historically for coal for steamships and Arctic outposts, including missions and schools. The Western Arctic Coal project would be of particular concern to Chukchi Sea coastal communities, as they attribute this project as having interfered with caribou harvests when last operational (USDOI, BOEMRE, 2011, Vol. II; Braund and Associates, 2013a).

Climate Change is the reasonably foreseeable event with the greatest potential to both change the baseline and result in adverse effects to subsistence onshore. The Terrestrial Mammals section (5.2.7 above) describes the ways in which climate change would affect caribou habitat and caribou herds. Barrow, Wainwright, Atqusak, Point Lay, Point Hope and Kivalina are among a number of Arctic communities that rely upon caribou as a keystone subsistence resource. Dwindling stocks would result in reduced hunting success and could have a ripple effect throughout sociocultural systems. These effects would be experienced regardless of Lease Sale 193 development.

Climate change, with resultant loss of summer sea ice and an open Northwest Passage, will likely draw visitors associated with recreation and tourism industries. Additional vessel traffic, especially cruise ship traffic, air traffic, and local traffic, could seriously impede subsistence harvests, as much of the visitation would occur during the prime season for subsistence harvests of beluga whales, seals, caribou, and fish. Pressure from increased sports hunting and fishing would further exacerbate adverse impacts on subsistence hunting and fishing.

Community and regional development is ongoing and is anticipated to accelerate in the future. Infrastructure necessary to support Arctic expansion and modernization of existing communities would be constructed. Reasonably foreseeable activities include, but are not limited to the following:

- Construction of bases for workers
- Expansion of airports, helipads, and hangers
- Marine coastal improvements
- Dredging of harbors
- Marine ways
- Fuel tank farms
- Docks
- Harbor Master facilities
- Search and rescue facilities
- Water and wastewater projects
- Roads
- Schools
- Other infrastructure

Most, if not all of these projects would require a Federal or State of Alaska funding and oversight, and governmental agencies should work closely with local communities and subsistence hunters who might benefit in many ways from construction of these facilities, but who might also experience adverse impacts to subsistence unless government agencies actively solicit local perspectives and traditional knowledge, and use the information in siting of infrastructure, work timing, and develop other means to avoid or reduce effects on subsistence harvests.

5.2.10.3. Analysis of Cumulative Impacts

The incremental contribution of activities associated with the Scenario to cumulative effects on subsistence harvest practices would vary in accordance with the type of activity, seasonal timing, the numbers of people drawn to the area for work or recreation, and animal migrations. It is assumed for the purpose of analysis that future lease sales in the Chukchi Sea would result in the construction of seven additional platforms and miles of connecting pipelines to extract oil and gas bring it to market. The effects could range from minor to major, depending upon the time of the year that activity would occur and if an oil spill were to happen. If construction occurs during the winter months and ceases sufficiently in advance of the Wainwright bowhead whale hunt, it would likely have a minor effect on marine subsistence use. Likewise, vessel and air traffic from the shore base to the Lease Sale area and back could have a major impact to Wainwright’s marine subsistence use unless mutually agreed upon corridors and altitude are maintained. If efforts are made to avoid the primary marine subsistence area offshore of Wainwright and other communities (such as Atqusak, Nuiqsut, Barrow and others), the level of impacts could be reduced to a moderate or even minor level. It is likely that onshore mining and oil and gas activities would have also had effects ranging from minor to moderate if specific mitigation measures are taken to avoid impacting subsistence. Impacts of community/economic development could range from minor to moderate, since the assumption is made that Federal, state, regional, and local governmental entities would work to mitigate effects on subsistence. Climate change will have a major adverse effect on subsistence hunting of caribou regardless of any effects produced by Lease Sale 193.

Throughout this document, the assumption has been made that subsistence harvest practices, so integral to sustaining Iñupiaq cultural practices and foundational to the entire sociocultural system, will continue throughout the 77-year life of the Lease Sale. The past century has seen adherence to the subsistence lifestyle in the face of incredible cultural change due to Westernization and globalization of the Arctic. It seems likely that in the context of past, present, and reasonably foreseeable future activities, subsistence practices will continue throughout this century and well into the next. This statement is predicated on good faith efforts to avoid, mitigate, and monitor subsistence through fostering a climate of mutual benefit and good will.

5.2.10.4. Summary/Conclusion

The reasonably foreseeable future actions described above would generate subsistence-harvest pattern impacts that are additive, synergistic, and also countervailing to those from the Proposed Action. The cumulative effects of these actions on subsistence harvests are quantifiable in the context of effects determinations, ranging from minor to major, depending upon the exogamous driver. In the case of climate change, adverse effects on subsistence resources such as caribou have been and continue to be uncontrolled. The contribution to cumulative impacts of the Proposed Action, as well as overall cumulative impacts to subsistence harvest patterns, would be major.

5.2.11. Sociocultural Systems

5.2.11.1. Summary of Direct and Indirect Effects

The Proposed Action Scenario could impact sociocultural systems by disrupting the social organization and/or institutional formation of communities, disrupting cultural values, and /or disrupting the economy of households and village communities through widespread changes in employment, personal income, demography, commodity pricing, or community prosperity. Such impacts could occur at localized community levels, regional Borough levels, statewide levels, or in the event of a large spill, on a national and international level.

Combined effects from OCS oil and gas activities over the life of the Scenario are anticipated to range from moderate to major. Periods of exploration, drilling, and construction activity would likely have a localized, short-term effect on communities due to potential harvest disruptions and the influx of transient workers. However, the construction of shorebase facilities and pipeline corridors could result in more extensive alterations to existing sociocultural patterns. If production occurs, sociocultural impacts from potential economic revenue would also be major, but primarily beneficial in nature. The greatest degree of impacts could occur from large spills, which could cause long-term tainting or perceived tainting of subsistence resources, making them unavailable or undesirable for use, while creating new impetus for broad social fragmentation and adversarial community relations. The highest likelihood of adverse impact occurs from Years 10-50, where exploration activities overlap with development and production activities. Once exploration drilling ceases, operational adverse impacts would likely decline (in the absence of a large spill), with lower levels of effect.

5.2.11.2. Discussion of Other Relevant Actions

Past, present and reasonably foreseeable infrastructure development projects along the Bering Sea coast and across the North Slope include: oil and gas development projects, community development, and mining projects. These various development projects are described in Section 5.1.2 and Tables 5-3 and 5-4. Such substantial actions, in combination with anticipated growth in vessel traffic, homeland security activities, and regional recreation and tourism, would likely generate additional disturbance to wildlife and could affect subsistence activities through displacement, altered habitat, threat of contamination, or other disruption to traditional living. Likewise, these actions could generate new economic activity in the form of employment, labor income, commodity prices, and property tax revenues, which would further impact sociocultural systems.

Most notably, the AK LNG, described in Section 2.3.5, is expected to occur during the same timeframe as the activities associated with the Proposed Action. The AK LNG would require substantial construction and manpower, which could put a strain on the supply of skilled labor in the region. Regional demographic trends toward growth and increasing diversity are likely to continue as more development projects occur. In-migration from transient labor pools would likely increase, while out-migration of Alaska Native residents would also likely increase. Out-migration from rural communities to urban communities throughout Alaska has been driven in recent years by both educational and economic opportunities. As the net population increases, local demand for public services and infrastructure would also increase.

Increased local tax revenues from new infrastructure would likely be used to expand capital budget projects and expand local infrastructure and services, such as: housing, water and sewage treatment, power supply, communication networks, road construction and maintenance, construction of airstrips, docks, health facilities, and public safety and rescue operations.

Climate change constitutes another significant consideration in the context of cumulative effects. As diminished sea ice coverage accelerates over time, several additional drivers of subsistence disruption are likely to occur from altered habitat and changes in wildlife distribution. Climate change could induce regional sociocultural effects through increased economic activities such as: commercial fishing, recreational fishing, coastal mining, renewable energy development, tourism, recreation, and marine shipping. These activities would require substantial levels of skilled labor and high value infrastructure, which would each add substantial new impacts to existing sociocultural patterns in the region.

5.2.11.3. Analysis of Cumulative Impacts

With regard to subsistence activities, increased construction and development of infrastructure would add synergistic disruption to alter habitat and wildlife foraging behaviors, with likely negative implications for subsistence success and harvest efficiency. Declining harvest efficiency would likely lead to an increase in hunting pressure on terrestrial wildlife, and to an increase in competition and spatial use conflicts among hunters. The increased competition and danger would likely spur new household expenditures while increasing local dependence on costly fuel, with corresponding increases in social stratification and fragmentation. Alaska Native adaptive capacity may be constrained as economic pressures on subsistence activities reduce the number of active hunters and force greater specialization. Diminished hunter access and harvest efficiencies would likely undermine the extent and health of sharing networks. It would likely intensify sharing effort among core kinship relations, but diminish it among more remote networks of exchange. Such pressures would also likely undermine cultural transmission to youth in general.

With regard to economic stimulus, increased employment and resulting increased population from the Proposed Action and other relevant foreseeable future actions would lead to increased demand for public services and infrastructure in the NSB. As described above, this includes increased demand for housing, water, waste disposal and storage, power supply, telecommunications, port/dock access, roads, etc. Population increases could also lead to future demographic changes as the region experiences an influx of outside cultures. This impact would likely be offset in part by zoning regulations to isolate work camps and industrial parks into enclaves that could diminish transient interaction with community activities. Much of the skilled labor and onshore infrastructure needed for the Scenario would also support other development and create substantial regional synergistic effects.

This increase in population and corresponding demand for public services and infrastructure could also amplify regional vulnerability to boom and bust cycles. Population growth during the 1970s and early 1980s was driven primarily by two converging factors: high oil prices and increases in the birth rate from those who settled in Alaska during the initial boom. As the activities associated with the Proposed Action wind down, the NSB and the State of Alaska could experience a net migration loss, leaving under-utilized or unused public services and infrastructure behind. Boom and bust cycles could also amplify inflationary pressure caused by rapidly increasing wage growth and increasing prices in the NSB and State. On the other hand, as existing large oil fields age and the assessed valuation of petroleum facilities depreciate, tax revenues and the bonding capacity of the Borough also declines. The current way of life that is supported by oil revenues will be difficult to maintain if funding for public services and government jobs diminish.

With regard to climate change, warming temperatures will intensify alterations in habitat and wildlife foraging behaviors, with corresponding consequences as described above.

5.2.11.4. Summary/Conclusion

The reasonably foreseeable future actions described above would generate sociocultural impacts that are additive, synergistic, and also countervailing to those from the Proposed Action. The overall cumulative impact on local and regional sociocultural systems would be major. Growth of tax revenue on the North Slope, with corresponding growth in the capital budget and provision of government services would provide substantial local benefit; however, dramatic cumulative changes in sociocultural systems would likely occur at a major level of effect. Since much of the large-scale infrastructural changes anticipated would be substantially facilitated or accelerated by the Proposed Action Scenario, the incremental contribution of the Scenario to cumulative effects would also be major.

5.2.12. Public Health

5.2.12.1. Summary of Direct and Indirect Effects

Impacts to marine and terrestrial mammals could impact subsistence-harvest patterns, which could in turn impact Public Health. The overall impacts of the Scenario to marine and terrestrial mammals varies by species, and although in general impacts are negligible to minor, some IPFs, such as aircraft traffic and spills, could result in moderate impacts to certain species. If subsistence-harvest patterns are affected, Public Health could be impacted due to a possible reduction in availability of subsistence resources, which could mean a reduction in diet quality if store-bought/processed foods are substituted for traditional subsistence foods.

Impacts to subsistence could also result in impacts to sociocultural systems, which could in turn impact Public Health. Impacts to subsistence would impact sociocultural systems by disrupting the social organization and/or institutional formation of communities, disrupting cultural values, and /or disrupting the economy of households and village communities through widespread changes in employment, personal income, demography, commodity pricing, or community prosperity. If sociocultural systems are disrupted, members of these systems would experience an increase in stress and nutrition-related issues, and would come to rely more heavily on community support infrastructure such as medical and counseling services.

Positive impacts to the economy over time would have corresponding positive impacts on Public Health due to additional funding available to improve community support infrastructure, although potential negative impacts could result from the increase in population as the workforce swells. This could result in more strain on support infrastructure if this influx is not mitigated through well-managed enclave development. Potential environmental impacts to marine and terrestrial mammals and air and water quality could negatively impact subsistence-harvest patterns and sociocultural systems, resulting in a moderate impact to Public Health.

A large spill could result in major negative impacts to Public Health through tainting and perceptions of tainting of subsistence resources, resulting in less nutritious store bought food being substituted for subsistence food, as well as the above described impacts to sociocultural systems.

Overall, impacts to Public Health from the Scenario have the potential to be major, both positively and negatively.

5.2.12.2. Discussion of Other Relevant Actions

Past, present and reasonably foreseeable infrastructure development projects along the Bering Sea coast and across the North Slope include: oil and gas development projects, community development, and mining projects. These various development projects are described in Section 5.1.2 and Tables 5-3 and 5-4. Such substantial actions, in combination with anticipated growth in vessel traffic, homeland security activities, and regional recreation and tourism, would likely generate additional disturbance to wildlife and could affect subsistence activities (and therefore Public Health) through displacement, altered habitat, threat of contamination, or other disruption to traditional living. Likewise, these actions could generate new economic activity in the form of employment, labor income, commodity prices, and property tax revenues, which would further impact sociocultural systems and by extension Public Health.

Most notably, the AK LNG, described in Section 2.3.5, is expected to occur during the same timeframe as the activities associated with the Proposed Action. The AK LNG would require substantial construction and manpower, which could put a strain on the supply of skilled labor in the region. Regional demographic trends toward growth and increasing diversity are likely to continue as more development projects occur. In-migration from transient labor pools would likely increase, while out-migration of Native residents would also likely increase. Out-migration from rural communities to urban communities throughout Alaska has been driven in recent years by both educational and economic opportunities. As the net population increases, local demand for public services and infrastructure would also increase.

Increased local tax revenues from new infrastructure would likely be used to expand capital budget projects and expand local infrastructure and services, such as: housing, water and sewage treatment, power supply, communication networks, road construction and maintenance, construction of airstrips, docks, health facilities, and public safety and rescue operations.

Climate change constitutes another significant consideration in the context of cumulative effects. As diminished sea ice coverage accelerates over time, several additional drivers of subsistence and public health disruption are likely to occur from altered habitat and changes in wildlife distribution. Climate change could induce regional sociocultural and public health effects through increased economic activities such as: commercial fishing, recreational fishing, coastal mining, renewable energy development, tourism, recreation, and marine shipping. These activities would require substantial levels of skilled labor and high value infrastructure, which would each add substantial new impacts to existing sociocultural patterns, and by extension to public health, in the region.

5.2.12.3. Analysis of Cumulative Impacts

Cumulative impacts to Public Health mirror those to Subsistence-Harvest activities and Sociocultural Systems. See sections 5.2.10 Subsistence-Harvest Patterns and 5.2.11 Sociocultural Systems for analysis of cumulative impacts to these resources.

The incremental contribution of activities associated with the Scenario to cumulative effects on public health would vary in accordance with the type and level of impacts to subsistence-harvest practices and sociocultural systems. It is assumed that future lease sales in the Chukchi Sea could result in the construction of additional platforms and miles of connecting pipelines to extract oil and gas bring it to market, the effects of which could range from minor to major, depending upon the time of the year of each activity and whether a spill were to happen. If construction occurs during the winter months and ceases sufficiently in advance of the Wainwright bowhead whale hunt, it would likely have a minor effect on marine subsistence use, sociocultural systems, and therefore, public health, as diets are impacted and social relationships are strained. It is likely that additional onshore mining and oil and gas activities outside of the Scenario would have also have effects ranging from minor to moderate, if specific mitigation measures are taken to avoid impacting subsistence. Climate change and warming temperatures will intensify alterations in habitat and wildlife foraging behaviors, with corresponding consequences as described above.

5.2.12.4. Summary/Conclusion

The reasonably foreseeable future actions described above would generate impacts to public health by impacting subsistence-harvest patterns and sociocultural systems. These impacts would be additive, synergistic, and also countervailing to those from the Proposed Action. The contribution of the Proposed Action to cumulative impacts on local and regional subsistence-harvest and sociocultural patterns would be major; therefore, the contribution of the Proposed Action to cumulative effects to public health would also be major due to changes in nutrition and social conditions. Growth of tax revenue on the North Slope, with corresponding growth in the capital budget and provision of government services would provide substantial local public health benefit as infrastructure such as medical facilities and schools are built. Since much of the large-scale infrastructural changes anticipated would be substantially facilitated or accelerated by the Scenario, the incremental contribution of the Scenario to the cumulative effect on public health would also be major.

5.2.13. Environmental Justice

Alaska Iñupiat Natives, a recognized minority, are the predominant residents of Chukchi Sea coastal communities in the North Slope Borough and in the Northwest Arctic Borough (NWAB), the area potentially most affected by the Leased Area and subsequent activities.

Effects on Iñupiat Natives would occur due to their reliance on subsistence foods, and cumulative effects may affect subsistence-harvest patterns. Potential effects from noise, disturbance, and spills on subsistence-harvest patterns and sociocultural patterns would focus on the Iñupiat communities of Barrow, Wainwright, Point Lay, Point Hope, Atqasuk, and subsistence communities on the Russian Chukchi Sea coast.

For a detailed discussion of Environmental Justice impact producing factors, see Section 4.3.14, and the cumulative effects analyses for subsistence-harvest patterns and sociocultural systems in the 2007 FEIS (Sections V.C.12 and V.C.13).

Sources that could affect subsistence-harvest patterns include potential increased seismic-survey activity, spills, noise and traffic disturbance, and disturbance from construction activities associated with ice roads, production facilities, pipelines, gravel mining, and supply efforts. Other communities potentially affected are Nuiqsut because it lies within an expanding area of oil exploration and development onshore (Alpine, Alpine Satellite, Northeast and Northwest NPR-A) and Kivalina due to the Red Dog Mine and the DeLong Port Facility expansion. Nearshore and onshore oil and gas development along with seismic-exploration activity, potential drilling operations off Kaktovik, and Canadian drilling off the McKenzie River Delta are also factors which may impact these communities and create environmental justice issues.

In the event of a large spill, many harvest areas and some subsistence resources could be unavailable for use. Some resource populations could suffer losses and, as a result of tainting or perceived tainting, bowhead whales could be rendered unavailable for use. Major additive effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together.

One or more important subsistence resources would become unavailable or undesirable for use for 1-2 years, a major effect. Increases in population growth and employment could cause long-term disruptions to:

- The kinship networks that organize the Iñupiat communities' subsistence production and consumption
- Extended families
- Informally derived systems of respect and authority (mainly respect of elders and other leaders in the community)

Cumulative effects on social organization could include decreasing importance of the family, cooperation, sharing and subsistence as a livelihood, and increased individualism, wage labor, and entrepreneurship. Long-term effects on subsistence-harvest patterns also could be expected.

Non-oil and gas development associated with military, residential, and commercial development have directly impacted several thousand acres of fish and wildlife habitat and have also indirectly affected habitat and animal behavior, effects that have accumulated and persist today. During the mid-20th Century, the Department of Defense contracted for the construction of DEW-line and WACS sites on the North Slope. During and after construction of these facilities indigenous residents could no longer hunt near these sites that, in most cases, were sited on or near important subsistence and traditional sites. Operation of these facilities by the military, and later by contractors, resulted in contamination of the surrounding area with fuel, oil, antifreeze, and other chemicals, leading to further avoidance of these sites by subsistence harvesters concerned about subsistence food contamination. Postwar oil exploration produced additive impacts on subsistence-harvest patterns and users. These activities cumulatively resulted in the loss of approximately 4,300 acres of habitat for subsistence species (USDOI, BLM, 2012).

The most intense oil and gas development activity occurred during the 1970s and early 1980s with the development of the Prudhoe Bay and Kuparuk oil fields, the construction of the Trans-Alaska Pipeline System, the Dalton Highway, and the construction of a large portion of the roads, drilling pads, gravel sources, collector pipelines, and regional production facilities. This activity has resulted in cumulative impacts to approximately 21,000 acres of habitat for subsistence species. (USDOI, BLM, 2012).

North Slope subsistence users have stated that there is a decline of fish populations due to onshore seismic survey activities, that caribou have been diverted from traditional migration routes and calving areas due to increased low-flying aircraft traffic, that caribou movements are disrupted due to the presence of low pipelines, and traditional harvest areas are displaced because of hunter avoidance of industrial areas. Oil and gas development in the Prudhoe Bay and Kuparuk areas affects subsistence harvests by causing subsistence hunters to avoid certain areas because of concerns about firearm safety, and specifically has discouraged Nuiqsut residents from using the eastern portions of their traditional harvest areas (USDOI, BLM, 2012).

Impacts to subsistence caused by seismic exploration programs have also been observed for many years. Although seismic testing no longer uses dynamite on fish bearing lakes, Iñupiat blame this activity for historic declines in fish numbers in the many interconnected lakes and streams used by subsistence fishermen. Arnold Brower, Jr. stated in scoping testimony for the 1998 Northeast NPR-A assessment process a consensus opinion among Iñupiat subsistence hunters that seismic testing, even in its current refined form, deflects subsistence animals from the areas it operates in (USDOI, BLM, 2012).

Although the North Slope and the northwest Arctic still has large areas that are relatively undisturbed, the general subsistence-hunting environment continues to change in response to increased development. The continued expansion of oil and gas development between the Colville and Canning Rivers will increase the area considered off-limits by subsistence users, could deflect or divert important subsistence resources from their normal routes, and require users to travel farther to harvest subsistence foods at a greater cost in terms of time, fuel, wear and tear on equipment and people, and lost wages (USDOI, BLM, 2012).

Oil and gas exploration and development have had impacts on the habitat use and behavior of subsistence species and potentially disrupted subsistence livelihoods. The Iñupiaq people would continue to be affected by future disturbances to key subsistence species that can lead to disruption, displacement, or long-term changes in species' populations. Expanded oil and gas development on- and offshore on both Federal and State leases would increase disturbance effects to subsistence species and harvest patterns. While individual projects likely contribute small incremental increases, the additive cumulative effect of this collection of discrete projects could become more repressive to the subsistence lifestyle.

Transportation facilities and activities also would contribute to cumulative effects to subsistence-harvest patterns and, consequently, to the Alaska Native population. The potential extension of seasonal or permanent roads into the northeast of the NPR-A might compound issues of conflict and smuggling alcohol and drugs into Nuiqsut and other North Slope communities (USDOI, BLM, 2012).

At the same time, revenues from NSB taxation on oil development have produced positive cumulative impacts that include increased funding for infrastructure, higher incomes (that can be used to purchase better equipment for subsistence), better health care, and improved educational facilities. For communities like Nuiqsut that are relatively close to oil-development activities on the North

Slope, cumulative effects chronically could disrupt sociocultural systems in the community. Wainwright, in the long term, could experience similar impacts.

The influx of money and a changing landscape due to wage employment has added many benefits, raised the standard of living, and produced other changes in the Iñupiat culture. The sources of cumulative effects are difficult to disaggregate though most cumulative effects result from onshore development as the oil patch spreads outward from Prudhoe Bay/Deadhorse. Most of the stress factors mentioned by local stakeholders normally can be associated with onshore impacts. Causal linkages to impacts on subsistence-harvest patterns, and Iñupiaq social systems from on- and offshore sources, would continue to be problematic, and even with improved monitoring regimes, these linkages would be difficult to establish.

Potential impacts on human health from long-term, cumulative effects impacting traditional culture, and community infrastructure of subsistence-based indigenous communities in the NSB and NWAB would be an expected. Potential disproportionately high adverse effects on low-income, minority populations in the region are expected to be mitigated substantially but not eliminated.

5.2.13.1. Summary/Conclusion

The Proposed Action would contribute additive, synergistic, and countervailing impacts to Iñupiat culture and social structure. In the event of a large spill, Alaska Natives could experience disproportionate high adverse effects due to the long-term inability to subsistence hunt. Under such circumstances, the Proposed Action’s contribution to cumulative effects (as well as overall cumulative effects from other actions) would be major.

5.2.14. Archaeological Resources

5.2.14.1. Summary of Direct and Indirect Effects

Direct effects to historical and archaeological resources include activities that physically impact the conditions or the integrity of the resource. These include but are not limited to the following:

- Drilling (both directional and tophole)
- Excavation for oil and gas pipelines on- and offshore
- Placement of platforms
- Construction of exploration and production bases
- Pump stations
- Roads
- All infrastructure associated with Lease Sale 193 involving ground disturbance

Anything that involves ground disturbance in a previously undisturbed area could be subject to archaeological surveys, analysis, reports, and consultation for compliance with Sec. 106 of the NHPA of 1966 as amended, as any of these activities could result in direct effects to surface or subsurface historic or archaeological resources either on- or offshore.

Impacts to offshore resources might occur through additive actions (redrilling an exploratory hole that contained the remains of an archaeological resource). Onshore historic and archaeological resources are also susceptible to impacts: (1) inadvertent damage, (2) looting caused by the introduction of an increased population with increased access, or local activity, and (3) visual effects to historic or archaeological traditional cultural properties.

Impacts to historic and archaeological resources resulting from implementation of the Proposed Action could be intensive and result in adverse effects if an archaeological site is impacted. Effects are difficult to assess since at this point, no archaeological sites have been physically identified in the

Alaska OCS region. The potential is high for locating these resources, since multiple lines of evidence point toward human occupation of Beringia (the Land Bridge) before it was flooded at the advent of the Holocene (Hoffecker, Elias, and O'Rourke, 2014). Additionally, there is a high potential to identify historic shipwrecks in the region, though this might be difficult even through use of the most advanced seismic and geophysical techniques. Therefore, the summary impact level of direct and indirect effects from the Proposed Action for archaeological sites is major.

5.2.14.2. Discussion of Other Relevant Actions

Currently, there are 35 fields producing oil on the North Slope and in nearshore areas of the Beaufort Sea, and additional discoveries are under development. North Slope oil and gas exploration, development, and production activities include the construction and operation of TAPS, permanent roads and winter ice roads, construction of support facilities, and transportation activities involving surface vehicles, aircraft, or marine traffic along the coast or within the barrier islands.

Confirmation of oil and gas prospects in the Leased Area would elicit interest that could result in additional lease sales in the OCS that could create synergistic and additive effects. OCS development at the Liberty prospect in the Beaufort Sea is expected to occur during the life of the Proposed Action. Construction and pipeline routes and onshore roads, barrow pits, and other expansion involving ground disturbance would proceed subject to Section 106 consultation.

Onshore oil and gas activities would include the Alaska Pipeline Project near Prudhoe Bay, with facilities to treat, transport, and deliver gas from the North Slope of Alaska to markets in North America and possibly overseas. These facilities could include the installation and operation of a gas treatment plant at Prudhoe Bay with construction targeted in the2015-2020 timeframe. The Point Thomson project, located approximately 60 miles east of Prudhoe Bay could include the construction of three production pads, process facilities, an infield road system, an export pipeline, infield gathering lines, and an airstrip. Since it is likely that seismic activities and geophysical activities would be refined and improved upon in the future, historic and archaeological resources, both on- and offshore, might be identified with greater accuracy than at present.

Mining activities include the following:

- Southwest Chukchi Sea, inland, Red Dog Mine
- Southwest Chukchi Sea coastal, Red Dog Port
- Western Chukchi Sea coastal, Western Arctic Coal project.

Because these projects would likely involve Federal licenses, permits, leases, or funding, they would be subject to the provisions of Sec. 106 of the NHPA. Surveys would be performed in the early planning stages and any historic or archaeological resource discovered would be tested to determine eligibility to the NRHP.

The military will continue to be a presence in the surrounding areas. At least nine Distant Early Warning sites dotted the coastline from the Canadian border to the Chukchi Sea in the past. These stations were constructed between 1954 and 1957, and decommissioned in the 1990s. Many of these sites have been remediated and decommissioning efforts that include demolition might continue. It is likely that the military vessels would be deployed from a harbor south of the Leased Area that would be developed as a port.

Climate Change is the reasonably foreseeable event with the greatest potential to both change the baseline and result in adverse effects to both on and offshore historic and archaeological resources. Melting permafrost, rising sea levels, shoreline erosion, storm surges, drying of lakes and ponds, and changing of river courses all have the present and reasonably foreseeable future effect of destroying, flooding, or altering the context and integrity of historic and archaeological resources. These adverse impacts would occur regardless of Federal oversight, and a great many historic and archaeological resources, previously unidentified and undocumented, could be lost.

Community and regional development is ongoing and is anticipated to accelerate in the future. Reasonably foreseeable activities include, but are not limited to the following:

- Construction of bases for workers
- Expansion of airports, helipads, and hangers
- Marine coastal improvements
  - Dredging of harbors
  - Marine ways
  - Fuel tank farms
  - Docks
  - Harbor Master facilities
- Search and rescue facilities
- Water and wastewater projects
- Roads
- Schools
- Other necessary infrastructure

Infrastructure necessary to support Arctic expansion and modernization of existing communities would continue to be constructed. Most, if not all of these projects would require a Federal license, permit, funds or otherwise be linked to Federal involvement, and thus would be under the auspice of the NHPA and attendant codes of Federal regulation. Climate change, with resultant loss of summer sea ice and an open Northwest Passage, would likely draw visitors associated with recreation and tourism industries. Many of these may well be outside of the purview of the NHPA yet would have the potential to cause adverse impacts to historic and archaeological resources.

5.2.14.3. Analysis of Cumulative Impacts

It is assumed for the purpose of analysis that future lease sales in the Chukchi Sea would result in the construction of seven additional platforms and miles of connecting pipelines to extract oil and gas and bring it to market. The effects could range from negligible to major, depending upon the ability to identify, avoid, or mitigate historic and archaeological resources during the early planning stages, if any should exist in the Leased Area. Development of the Liberty Project in the Beaufort Sea would result in analogous effects on historic and archaeological resources as future lease sales in the Chukchi Sea. It is likely that onshore mining and oil and gas activities would have a negligible effect because of adherence to NHPA. It is also likely that community/economic development could range from negligible to moderate, since NHPA might not apply, and there is the possibility that ground disturbance could adversely impact a significant historical or archaeological resource. Climate change would have a major adverse effect on historic and archaeological resources regardless of the any effects produced by Lease Sale 193.

In general, impacts would be managed under NHPA with associated inventory, assessment, evaluation of effects, and mitigation plans. With regard to climate change, adverse effects on historic and archaeological sites have been and will continue to be uncontrolled and undocumented. There are no comprehensive plans underway to organize broad scale efforts to identify, document, and assess vulnerable and threatened sites. Despite this drawback, it can be assumed that the number of historic and archaeological resources would increase through identification efforts resulting from federally-licensed, leased, permitted, and funded activities. The historic preservation process is fundamental to providing greater insight and understanding of the past. The discovery of any archaeological site in the Chukchi Sea would have profound significance in providing insight on the earliest human expansion to what is now North America. Thus, while effects on historical and archaeological sites would be major if they were to receive direct adverse impacts, the overall effect of knowledge gained from site identification during the planning stages would represent a countervailing effect by contributing in a major way toward unlocking the secrets of the past.

5.2.14.4. Summary/Conclusion

The incremental contribution of activities associated with the Proposed Action to cumulative effects on historic and archaeological resources would range from negligible to major, depending on whether archaeological sites are detected and avoided. With the safeguards already in place through NHPA and the Federal permitting process, the activities associated with the Proposed Action are unlikely to produce harmful incremental effects. However, if an unknown site is impacted by the Proposed Action and the information that site could have provided is lost, the overall contribution to cumulative impacts to archaeological resources would be major.

Chapter 6

Consultation and Coordination

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CHAPTER 6. CONSULTATION AND COORDINATION

6.1. Development of the Proposed Action and 2007 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 Lease Sale during the 2002-2007 Five-Year Program, which expired on June 30, 2007. Chukchi Sea OCS Oil and Gas Lease Sale 193 was subsequently included in the 2007 2012 Five-Year Program.

Information on the prelease and NEPA processes for Lease Sale 193 can be found in the 2007 FEIS (Sections I.D and VI).

6.2. Development of the 2011 Final SEIS

A Notice of Intent to Prepare a Supplemental Environmental Impact Statement (75 *FR* 61511) was published in the Federal Register on October 5, 2010. BOEM subsequently released a Draft SEIS in October 2010 and then a Revised Draft SEIS in May 2011. Each draft document underwent a thorough public review process that included:

- Publishing a Notice of Availability in the Federal Register
- Updating the agency website and providing a link to the draft document
- Mailing hard copies and computer disks of the draft document to Tribal and local governments, local libraries, and other parties who expressed interest in BOEM NEPA documents
- Holding a series of public meetings, Government-to-Government consultations, and Government-to-ANCSA Corporation consultations in five potentially affected villages along the Chukchi Sea coast, as well as in Anchorage
- Placing newspaper advertisements in two editions of the Arctic Sounder, the Fairbanks News-Miner, and the Anchorage Daily News
- Running public service messages on the two public radio stations serving the North Slope – FBRW 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 BOEM community advisories and, thereby, the opportunity to follow up with additional announcements or stories
- Receiving and integrating relevant and substantive information from more than 500,000 (150,000 regarding the Draft, and 360,000 regarding the Revised Draft) comments into the Final SEIS analysis, and then recording appropriate responses to all comments in a responses to comments appendix.

The Final SEIS was released in August 2011, and a Record of Decision issued October 3, 2011.

6.3. Development of this Second SEIS

The Second SEIS was developed by BOEM as a lead agency with five cooperating and five participating agencies, and released to the public on October 31, 2014 through a press release and posting on the bureau's website. BOEM published the Notice of Availability in the Federal Register on November 7, 2014.

Review of the Draft Second 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 received a printed or CD copy of the Draft Second SEIS, or were notified by a post card regarding how to obtain a copy (Table 6-1).

Table 6-1. Organizations, Entities, and Individuals Who Received Physical Copies or Notification by Post-card of the Draft Second SEIS.

Federal - Executive Branch	
Department of the Interior - Office of Environmental Policy & Compliance, Anchorage, AK; Special Assistant to the Secretary of the Interior, Anchorage, AK	**National Oceanic and Atmospheric Administration** - Dept of Commerce; National Marine Fisheries Service (Alaska Regional Office, Regional Administrator; Resource Ecology & Fisheries Mgmt; National Ocean Service, Policy, Planning & Analysis Division; Office of Response & Restoration; Scientific Support Coordinator for Alaska; NEPA Coordination & Compliance; Alaska Fisheries Science Center - National Marine Mammal Lab; Emergency Response Division
Bureau of Land Management - Alaska State Director; Fairbanks District Office	**US Arctic Research Commission** - Anchorage, AK
Bureau of Ocean Energy Management - Regional Directors for the Gulf of Mexico and Pacific OCS Region	**Marine Mammal Commission**
Bureau of Indian Affairs - Regional Director, Anchorage	**Department of Defense** - US Army Corps of Engineers
National Park Service - Regional Director; Subsistence Division; Superintendent	**Department of Homeland Security** - US Coast Guard, Anchorage, AK
US Fish & Wildlife Service - Director, Region 7; Chief, Endangered Species Branch; Assistant Regional Director, Subsistence and Fisheries; Migratory Bird Management, Endangered Species Branch	**Office of the Federal Coordinator for the Alaska Natural Gas Transportation Project** - Anchorage, AK
Bureau of Safety & Environmental Enforcement - Regional Director, Alaska; Environmental Enforcement Division, Anchorage AK	
US Geological Survey - Regional Director; Director, Alaska Science Center	
Federal - Legislative Branch	
Honorable Mark Begich, Senator	Honorable Lisa Murkowski, Senator
Honorable Don Young, House Representative	
Federal - Administrative Agencies and Other Agencies	
Environmental Protection Agency - Alaska Operations Office; Region 10, Seattle	
State of Alaska	
Office of the Governor, Juneau, AK; Associate Director State-Federal Relations, Washington, DC	**Dept of Fish & Game** - Wildlife Conservation Division; Subsistence Division; Region II, H & R Chief
Dept of Community & Regional Affairs - Commissioner	**Dept of Natural Resources** - Commissioner; Office of Project Management & Permitting; Executive Director, Large Project Coordinator; Director, Division of Oil & Gas; Citizens' Advisory Commission on Federal Areas
Dept Of Environmental Conservation - Northern Alaska District Office; Division of Water; Anchorage District Office	**State Pipeline Coordinator**, Joint Pipeline Office, Anchorage, AK
Alaska Division Of Community & Regional Affairs	
Tribal Governments	
Inupiat Community of the Arctic Slope	Native Village of Kotzebue IRA
Nagsragmuit Tribal Council	Native Village of Nuiqsut
Native Tribal Village of Atqasuk	Native Village of Point Hope
Native Village of Barrow	Native Village of Point Lay
Native Village of Kaktovik	Native Village of Shishmaref
Native Village of Kivalina	Native Village of Wainwright
Alaska Native Organizations	
Alaska Beluga Whale Committee	Inalik Native Corporation
Alaska Eskimo Whaling Commission	Kaktovik Inupiat Corporation
Alaska Intertribal Council Environmental Program	Kaktovik Whaling Captains

Alaska Native Knowledge Network	Kikiktagruk Inupiat Corporation
Alaska Native Science Commission	Kuukpik Village Corporation
Alaska's "Big Village" Network	NANA Regional Corporation
Arctic Slope Native Association	Nunamiut Corporation
Arctic Slope Regional Corporation	Olgoonik Corporation
Atqasuk Inupiat Coordination	Point Hope Whaling Captains Association
Barrow Whaling Captains Association	Tikigaq Corporation
Cully Corporation	Ukpeagvik Inupiat Corporation
Eskimo Walrus Commission	
Local Governments	
City Manager, City of Nome	**Mayor, City of Kotzebue**
City of Kotzebue, Planning Division	**Mayor, City of Nuiqsut**
Mayor, City of Anaktuvuk Pass	**Mayor, City of Point Hope**
Mayor, City of Barrow	**Mayor, City of Wainwright**
Mayor, City of Kaktovik	**Mayor, North Slope Borough**
North Slope Borough - Department of Wildlife Management; Village Coordinator Anaktuvuk Pass; Planning & Community Services; Department of Wildlife Management; Law Dept; Planning Dept; Barrow; Public Information Office, Barrow; Village Coordinator, Kaktovik; Village Coordinator, Point Hope; Village Coordinator, Wainwright; and Village Coordinator. Atqasuk; Planning Dept	**Mayor, Northwest Arctic Borough, Kotzebue**
Organizations, Corporations, Associations, Academia, and Other Groups	
Alaska Clean Seas	LGL Alaska Research Associates, Inc.
Alaska Conservation Foundation	LGL Limited, Environmental Research Associates
Alaska Dispatch News	Liberty Petroleum Corp.
Alaska Journal Of Commerce	Living Resources, Inc.
Alaska Magazine	Marathon Oil Company, Alaska Asset Team
Alaska Marine Conservation Council	Marine Advisory Program
Alaska Natural Gas Transportation Projects	Mat-Su Valley Frontiersman
Alaska Natural Heritage Program	Murphy Exploration & Production Company International
Alaska Oil & Gas Association	National Audubon Society
Alaska Oil & Gas Conservation Commission	National Ocean Industries Association
Alaska Public Interest Research Group	National Parks And Conservation Association
Alaska Public Radio Network	National Wildlife Federation
Alaska Star, Editor	News Director, KBBI Public Radio
Alaska Support Industry Alliance	News Director, KBRW News
Alaska Wilderness League	News Director, KENI-AM News
American Petroleum Institute, Exploration Affairs Dept	News Director, KFQD-AM (Anchorage)
Anadarko Petroleum Corporation	News Director, KICY (Nome)
Applied Sociocultural Research	News Director, KINY-AM (Juneau)
Aqqaluk High / Noorvik Elementary	News Director, KJNO-AM (Juneau)
Arctic Sounder	News Director, KNBA-FM News
Armstrong Oil & Gas, Inc.	News Director, KNOM Radio (Nome)
Associated Press, Anchorage, AK	News Director, KTOO-FM (Juneau)
Battelle Duxbury Operations	News Director, KUAC-FM (Fairbanks)
Belmar Engineering	News Director, KWVV-FM (Homer)
Bering Air, Inc.	News Director, KYUK-AM (Bethel)
Bessenyey & Van Tuyn LLC	Nome Nugget Newspaper
BHP Billiton Petroleum (Americas) Inc.	North American Civil Recoveries Arbitrage Corp
Boyd, Chandler & Falconer LLP	Northern Alaska Environmental Center
BP Exploration (Alaska), Inc.	Northwest Arctic Borough School District
Cascadia Wildlands Project	Peninsula Clarion
ConocoPhillips Alaska, Inc.	Petrobas America, Inc.
ConocoPhillips Company, Houston, TX	Petro-Canada (Alaska) Inc.
Continental Shelf Associates	Petroleum News
Cook Inlet Energy, LLC	Pioneer Natural Resources Company
Craig Law Center	Prince William Sound, Regional Citizen's Advisory Council

Devon Energy Production Company LP	Radarsat International, Canada
Earthjustice	Repsol E&P USA, Inc.
Editor, Alaska Business Monthly	Shell Frontier Oil & Gas, Inc.
Editor, Capitol City Weekly, Juneau	Shell Gulf Of Mexico, Inc.
Editor, KATB-FM	Sierra Club Alaska
Editor, KJNP-FM/AM (North Pole)	Statoil E&P USA, Inc.
Editor, Valdez Star	Terris, Pravik, & Millian
ENI Petroleum Exploration Co., Inc.	Texaco, Inc.
Environ	The Wilderness Society
Environmental Defense, San Francisco, CA	Total American Services, E&P USA, Inc.
Exxon Valdez Oil Spill Trustee Council	Total E&P USA, Inc.
Exxon-Mobil Corporation	Trustees for Alaska
Exxon-Mobil Production Company	Turnagain Times, Editor
Fairbanks Daily News-Miner	UAA - Institute of Social & Economic Research
Geomarine Associates Ltd	UAA – ISER
Guess & Rudd P C	UAF – Institute Of Arctic Biology
Hanson Environmental Research Services	UAF - School of Fisheries & Ocean Sciences
Hess Corporation	University of Alaska Fairbanks, Geophysical Institute
Hilcorp Alaska, LLC	University of California, School of Social Science
Ilisagvik College, Barrow, AK	University of Louisiana Lafayette - Sociology/Anthropology Dept
International Arctic Research Center	University of Virginia, Environmental Sciences Dept
Inupiat Heritage Center	URS Corp, Environmental & Planning Group Mgr
Iona Energy Company (US) Limited	Vaudrey & Associates, Inc.
Juneau Empire	Vinson & Elkins LLP
KBRJ-FM	Western Geco
KCHU Public Radio (Valdez)	Wilderness Society
KVAK Radio (Valdez)	World Wildlife Fund
LexisNexis Academic & Library Solutions	
Libraries	
AK Pacific University, Academic Support Center Library, Anchorage, AK	Koyuk City Library, Koyuk, AK
Alakanuk Public Library, Alakanuk, AK	Librarian, UAF - Institute of Arctic Biology, Fairbanks, AK
Alaska Pacific University, Academic Support Center Library, Anchorage, AK	NEPA Natural Resources - Navy Library
Alaska Resources Library & Information Services, Anchorage, AK	NOAA Library
Alaska State Library, Juneau, AK	Noel Wien Library, Fairbanks, AK
Amoco Production Company Library, Houston, TX	Shishmaref School Library, Shishmaref, AK
Cameron Circumpolar Library (Science & Technology), Canada	Stebbins Community Library, Stebbins, AK
Elmer E. Rasmuson Library, Fairbanks, AK	Ticasuk Library, Unalakleet, AK
Establishment Pacific National Defense, Defense Research Library, Canada	Tikigaq Library, Point Hope, AK
Ilisaavik Library, Shishmaref, AK	Trapper School Community Library, Nuiqsut, AK
Juneau Public Library, Juneau, AK	Tuzzy Consortium Library, Barrow, AK
Katie Tokienna Memorial Library, Wales, AK	UAA Consortium Library - Government Documents, Anchorage, AK
Kaveolook School Library, Kaktovik, AK	University of Alaska Southeast Library, Juneau, AK
Kegoyah Kozga Public Library, Nome , AK	Valdez Consortium Library, Valdez, AK
Kenai Community Library, Kenai, AK	Wales School Library, Wales, AK
Kiana Elementary School Library, Kiana, AK	
Foreign Entities and Individuals	
Canadian Wildlife Service, National Wildlife Research Center	Geological Survey of Canada, Bedford Institute of Oceanography
Consul, Canadian Consulate, Anchorage, AK	Indian Affairs & Northern Development, Canada
Consulate General Of Canada, Seattle, WA	Librarian, Joint Secretariat, Canada
Dept of Fisheries & Oceans, Institute of Ocean Sciences, Canada	Wrangel Island Nature Reserve, Moscow, Russia

Editor, CKRW Radio, Canada	
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Brenda Morgan, Winston Salem, NC	Kattanyna Bennett, Juneau, AK
Bruce Hazen, Elkwood City, PA	Kenneth Tagarook, Wainwright, AK
Carol Ampel, Medford, OR	Kimberly Donovan, Elkwood City, PA
Chris & Amy Gulick, North Bend, WA	Lon Sonsalla, Kaktovik, AK
Chris Jacobs, Craftsbury Common, VT	Manika Schultz, Indianapolis, IN
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Enoch Oktollik, Wainwright, AK	Merilyn Traynor, Kaktovik, AK
Freddie Aishanna, Kaktovik, AK	Nolan Soloman, Kaktovik, AK
Fredrick Ahmaogak, Wainwright, AK	Pam Mackey, Marion, IA
George Tagarook, Kaktovik, AK	Paul Davis, Anchorage, AK
Gordon Brower, Barrow, AK	Paul Gronholdt, Sand Point, AK
Gordon Matumack, Nuiqsut, AK	Peter McKay, Kenai, AK
Harry Tazruk, Wainwright, AK	Rebecca Hepson, Anchorage, AK
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John Bockstoce, S Dartmouth, MA	Walt Audi, Kaktovik, AK
John Strasenburgh, Talkeetna, AK	Wasku Williams, Barrow, AK
Johnny Adams, Barrow, AK	William Risser, Houston, TX
Joseph K. Akpik, Barrow, AK	

6.4. Consultation

BOEM has engaged in several consultation and coordination processes with Federal regulatory agencies in regards to proposed activities under Lease Sale 193. Below is a brief summary of how BOEM has satisfied, or will satisfy, its requirements under various Federal regulatory processes.

6.4.1. Tribal Consultation

Executive Order 13175 requires Federal agencies to consult, on a government-to-government basis, with federally-recognized Indian tribes (to include Alaska Native tribes and communities) when developing Federal policies with tribal implications. The purpose is to "have an accountable process to ensure meaningful and timely input by tribal officials in the development of regulatory policies that have tribal implications." The order requires the head of each agency to designate an official "with principal responsibility for the agency's implementation" of the order.

Secretary of the Interior Ken Salazar issued Order 3317 on December 1, 2011, to update, expand, and clarify the Department's policy on consultation with Indian tribes in compliance with E.O. 13175. In summary, Order 3317 states that USDOl officials must demonstrate a meaningful commitment to consultation "by identifying and involving Tribal representatives in a meaningful way early in the planning process," and that consultation aims to create effective collaboration emphasizing "trust, respect, and shared responsibility..."

BOEM has determined that oil and gas leasing activities in the Chukchi Sea could have tribal implications for the several village tribes along the Chukchi Sea coast, along with one regional tribal entity. BOEM has offered to consult with each of these tribal governments at venues within various North Slope villages, or in the alternative, via telephone (an accepted communications practice among tribal members and within the villages of the Northwest Arctic Borough and North Slope Borough).

On August 10, 2012, the Department of the Interior issued a Policy on Consultation with Alaska Native Claims Settlement Act (ANCSA) Corporations. In this policy, Secretary of the Interior Ken Salazar restated a provision of ANCSA requiring that "[t]he Director of the Office of Management and Budget [and all Federal agencies] shall hereafter consult with Alaska Native corporations on the same basis as Indian tribes under Executive Order 13175." Additionally, the policy "distinguishes the Federal relationship to ANCSA Corporations from the government-to-government relationship between the Federal Government and federally recognized Indian Tribes... and [states that] this Policy will not diminish in any way that relationship..."

For this Second SEIS, BOEM initiated government-to-government tribal consultations by delivering letters to tribes whose members could be affected by Lease Sale 193 related activities, including:

- Kotzebue IRA
- Native Village of Point Hope
- Native Village of Point Lay
- Native Village of Wainwright
- Native Village of Barrow
- Inupiat Community of the Arctic Slope
- Tanana Chiefs Conference

BOEM initiated the government-to-ANCSA Corporation consultations through letters to ANCSA corporations whose members could be affected by Lease Sale 193 related activities, including:

- Arctic Slope Regional Corporation
- NANA Regional Corporation
- Cook Inlet Region, Inc.
- Doyon Limited
- Bering Straits Native Corporation
- Chugach Alaska Corporation
- Kotzebue – Kikiktagruk Inupiat Corporation (KIC)
- Point Hope – Tikigaq Corporation
- Point Lay – Cully Corporation
- Wainwright – Olgoonik Corporation
- Barrow – Ukpeagvik Inupiat Corporation (UIC)

BOEM conducted government-to-government consultations with the Native Village of Kotzebue, Native Village of Wainwright, and the Inupiat Community of the Arctic Slope. BOEM held ANSCA corporation consultations with Cully Corporation, the ANCSA Village Corporation for Point Lay.

6.4.2. ESA Section 7

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, BOEM consults with USFWS and NMFS (the "Services") for listed species under each Service's jurisdiction. For ESA consultation on proposed lease sales in Alaska, BOEM and BSEE specifically request incremental Section 7 consultations. 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), that there is a reasonable likelihood that the entire action will not violate Section 7(a)(2), and that the agency continues consultation with respect to the entire action, obtaining a biological opinion for each step. Thus, at the lease-sale stage, BOEM and BSEE consult 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. BOEM is required to re-consult for any proposed development and production activities.

A discussion on the ESA Section 7 consultation related to Lease Sale 193 is provided in the 2007 FEIS (Section VI.D) and the 2011 SEIS (Section VI.C, p. 320). In 2012, USFWS issued its Biological Opinion for Lease Sale 193, as well as past and proposed lease sales and subsequent exploration activities in the Beaufort and Chukchi Planning Areas. NMFS issued its Biological Opinion for those lease sales and activities in 2013. The full NMFS and USFWS Biological Opinions are available on BOEM's website at: http://www.boem.gov/ak-consultations/.

BOEM and BSEE have reinitiated Section 7 consultation with both the USFWS and NMFS on the new Scenario for Lease Sale 193 and related post-lease activities. BOEM, with BSEE assistance, has prepared Biological Assessments and provided these to the Services. While the reinitiated consultations are ongoing, the existing NMFS and USFWS Biological Opinions contain the relevant Incidental Take Statement and the terms and conditions and reasonable and prudent measures applicable to Lease Sale 193 and any post-lease activities should they be proposed during the exploration increment. BOEM and BSEE expect that if updated take estimates or new terms and conditions or reasonable and prudent measures are identified by the Services as part of the reinitiated consultations, they will supplement the existing Biological Opinions and be applied to post-lease activities as mitigations, where appropriate.

6.4.3. Essential Fish Habitat Consultation

The Magnuson-Stevens Fishery Conservation and Management Act (as amended) requires Federal agencies to consult with NMFS regarding actions that may adversely affect designated Essential Fish Habitat (EFH). In 2006, BOEM 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. In July 2011, BOEM submitted an additional EFH assessment and formal determination to NMFS which addressed these newly-designated EFH (2011 SEIS, VI.C.2. p. 321).

BOEM prepared a programmatic EFH assessment that addresses adverse effects to designated EFH from potential oil and gas exploration activities in the Chukchi Sea OCS. This programmatic assessment was provided to NMFS prior to releasing a Final SEIS.

6.4.4. Section 106, National Historic Preservation Act Consultation

The National Historic Preservation Act requires Federal agencies to consult with the appropriate State Historic Preservation Officer (SHPO) regarding any agency undertaking with the potential to affect historic properties. On January 30, 2007, BOEM initiated Section 106 consultation with the Alaska SHPO for the proposed Chukchi Sea Oil and Gas Lease Sale 193. BOEM identified two historic resources (shipwrecks) in the Chukchi Sea Planning Area and identified the specific lease blocks (see 2007 FEIS). At the time of the proposed lease sale EIS, no bottom-disturbing activities were anticipated and BOEM requested the SHPO's concurrence that proposed Lease Sale 193 would have "no effect upon known offshore historic and/or prehistoric resources." Concurrence was received from the SHPO on March 2, 2007.

While no additional Section 106 consultation will be necessary for Lease Sale 193 or this Second SEIS process, additional project- and site-specific consultations will occur as needed for any proposed exploration, development, production, and decommissioning activities.

6.4.5. Coastal Zone Management Act Consistency Review

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 Lease Sale 193 with the Alaska Coastal Zone Management (CZM) program. The document evaluated potential effects from the sale action and from hypothetical exploration and development activities outlined in the FEIS analysis. The MMS found that the proposal was consistent, to the maximum extent practicable, with the state’s CZM program, 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 is consistent to the maximum extent practicable with the Alaska Coastal Management Program (ACMP) and the local district’s enforceable policies.

In 2011, the State of Alaska did not pass legislation required to extend the ACMP, allowing the ACMP to sunset on July 1 of that year. With the termination of the ACMP, there are no enforceable standards on which to base a consistency review of Federal coastal development activities.

6.5. Authors, Reviewers, and Supporting Staff

BOEM staff with a wide variety of expertise in appropriate scientific, economic, and sociocultural disciplines contributed to the development of this Second SEIS and the analysis herein. Representatives from NOAA, National Marine Fisheries Service, and National Ocean Service offices also reviewed a draft document of the Second SEIS. Table 6-2 lists the primary individuals involved, their professional position, and their role in preparing and reviewing the SEIS.

Table 6-2. Primary Contributors to Development and Analysis of this Second SEIS.

Name	Professional Position	Role In Preparation
Augustine, Gene	Interdisciplinary Biologist	Analysis: Vegetation And Wetlands
Banet, Susan	Chief, Resource Analysis Section	Review: Public Comments and Technical
Benedetti, Deanna	Executive Assistant	Review: Public Comments
Bennett, James	Acting Regional Supervisor, Office of Environment	Management Review - Final
Blackburn, Scott	Chief, Environmental Analysis Section I	Supervisory Project Lead (For Second SEIS); Scenario; NEPA Review
Blazek, Matthew	Mineral Leasing Specialist	Review: Public Comments
Blood, Heather	Program Management Officer	Review: Public Comments
Boland, Greg	Biological Oceanographer	Review
Bradway, Michael	Geologist	Review: Public Comments
Brian, Jerry	Socioeconomic Specialist	Analysis: Economics and Review of Public Comments
Byrne, Martin	Cartographic Specialist	GIS Map Production
Campbell, Chris	Sociocultural Specialist	Analysis: Archaeological; Analysis in Final – Subsistence Harvest Patterns, Sociocultural Systems, Public Health, and Environmental Justice
Cody, Mary	Wildlife Biologist	Analysis for Draft: Marine Mammals
Coon, Catherine	Marine Biologist	Review: Public Comments
Cranswick, Deborah	Environmental Protection Specialist	Review: Public Comments, Response to Comments, and Technical
Crews, Chris	Wildlife Biologist	Analysis: Marine Mammals, Terrestrial Mammals
Deschu, Nancy	Fisheries Biologist	Analysis in Draft: Fish, Water Quality
Desselles, Richard	Petroleum Engineer	Scenario Development; Technical Review
deZeeuw, Maureen	Wildlife Biologist	Analysis: Final Marine and Coastal Birds
Holder, Tim	Sociocultural Specialist	Review And Coordination Between HQ and Region

Name	Professional Position	Role In Preparation
Holiday, Dan Ph.D.,	Biological Oceanographer	Analysis: Lower-Trophic Organisms; Vegetation and Wetlands
Horowitz, Warren		Review: Public Comments
Hunter, Melanie	NEPA Coordinator	Project Lead; NEPA Review
Jordan, Brian Ph.D.	Archaeologist	Review: Archaeology
Johnston, David	Regional Supervisor, Office of Leasing and Plans	Review: Leasing Process and Technical
Kendall, James J. Ph.D.	Regional Director	Management Review
Lau, Betty	Petroleum Engineer	Scenario Development; Technical Review
Laubenstein, Karen	Writer/Editor, BLM	Response to Comments Appendix
Lima, James Ph.D.	Senior Mineral Leasing Specialist	Author: Response to Comments
Mann, Frances	Chief, Environmental Analysis Section II	Supervisory Project Lead; Scenario; NEPA Review
McKee, Caron	Technical Writer/Editor	Document Review and Preparation
McWilliams, Parker	Leasing Administration Specialist	Review: Public Comments
Murphy, Constance	Writer-Editor	Document Review and Finalization
Raps, Virginia	Meteorologist	Analysis: Climate and Air Quality
Rasser, Michael	Marine Ecologist	Review
Raymond, Richard	Wildlife Biologist	Review: Public Comments
Rolland, Michael	Chief, Leasing Section	Review: Public Comments and Technical
Rose, Marshall	Chief, Economics Division	Scenario Development; Technical Review
Routhier, Michael	Program Analysis Officer	Project Manager, Second SEIS Process, Technical Review under NEPA
Schroeder, Mark	Wildlife Biologist	Analysis: Marine and Coastal Birds
Seymour, Jill Marie	Wildlife Biologist	Analysis: Final Marine Mammals
Sherwood, Kirk	Geologist	Scenario Development; Technical Review
Smith, Caryn	Oceanographer	Analysis: Sea Ice, Hydrocarbon Release Scenarios
Spealman, Betty	Executive Assistant	Review: Public Comments
Strellec, Kristen	Economist	Review: Economy
Swears, Bill	Technical Writer/Editor	Document Review and Preparation
Warren, Sharon	Deputy Regional Director	Regional Management Review
Wall, Rance	Regional Supervisor, Resource Evaluation	Review: Scenario Development and Technical
Wedemeyer, Kathleen	Fisheries Oceanographer	Review: Public Comments
Wikel, Geoffrey	Chief, Branch of Environmental Coordination	Scenario; General Review
Woehr, James	Biologist	Review: Marine and Coastal Birds
Wolvovsky, Eric	Meteorologist	Review: Air Quality
Wright, Frank	BOEM Liaison to ASLM	Review: Public Comments and Response to Comments
Youngblood, Jennifer	Sociocultural Specialist	Analysis in Draft: Subsistence, Sociocultural, Public Health, and Environmental Justice

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Chapter 7

Literature Cited

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The Department of the Interior Mission

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 sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; 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 ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island communities.

BOEM
Bureau of Ocean Energy Management

The Bureau of Ocean Energy Management Mission

The Bureau of Ocean Energy Management (BOEM) promotes energy independence, environmental protection, and economic development through responsible, science-based management of offshore conventional and renewable energy.